TRANSACTIONS

OF THE

HERTFORDSHIRE NATURAL HISTORY SOCIETY.

VOL. III.

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TRANSACTIONS

OF THE

HERTFORDSHIRE

NATURAL HISTORY SOCIETY

AND

FIELD CLUB.

EDITED BY JOHN HOPKINSON, F.L.S., F.G.S.

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CONTENTS.

PAGE

1. The Diatomaceæ ; with special reference to Species found in the Neighbourhood of Hertford. By Isaac Robinson 1
2. The Recorded Occurrences of Land and Fresh-water Mollusca in Hertfordshire. By W. Denison Roebuck, F.L.S., and John W. Taylor 10
3. Remarks on the Land Mollusca, with reference to their investigation in Hertfordshire. By John Hopkinson, F.L.S., F.G.S. 17
4. List of Land and Fresh-water Mollusca observed in Hertfordshire. By Ada Selby ; J. Gwyn Jeffreys, LL.D., F.R.S., F.L.S., F.G.S. ; W. S. A. Griffith, F.R.C.S. ; and Alfred T. Brett, M.D. Compiled by John Hopkinson, F.L.S. 29
5. Notes on Boulders and Boulder-clay in North Hertfordshire. By H. George Fordham, F.G.S. (With two Plates.) 33
6. On the Microscopic Structure of Boulders found in the North of Hertfordshire. By J. Vincent Elsden, B.Sc., F.C.S. (With three Plates.) 47
7. Notes on Lepidoptera observed in the Neighbourhood of Sandridge, Herts. By A. F. Griffith, M.A. 58
8. Notes on Mosses, with an Outline of a Hertfordshire Moss-Flora. By A. E. Gibbs.. 67
9. Notes on Birds observed in Hertfordshire during the year 1883. By John E. Littleboy 82
10. Report on Insects observed in Hertfordshire during the year 1883. By F. W. Silvester, F.R.Met.Soc... .. 91
11. Notes on the Protozoa of Hertfordshire : Section Discostomata. By F. W. Phillips, F.L.S. (With a Plate.) 95
12. List of Flowering Plants observed in Hertfordshire during the year 1883. By Ada Selby 101
13. Meteorological Observations taken at Throcking, Herts, during the year 1883. By the Rev. C. W. Harvey, M.A., F.R.Met.Soc. 103
14. Report on the Rainfall in Hertfordshire in 1883. By the Rev. C. W. Harvey, M.A., F.R.Met.Soc. 112

PAGE

15. On Instinct. By F. Maule Campbell, F.L.S., F.Z.S. .. 119
16. The Origin and Composition of Chalk and Flint, with special reference to their Foraminifera and other Minute Organisms. By Professor T. Rupert Jones, F.R.S., F.G.S. 143
17. Anniversary Address. By the President, the Right Honourable the Earl Cowper, K.G. 157
18. List of Works on the Geology of Hertfordshire, 1874-83. By John Hopkinson, F.L.S., F.G.S., etc. 165
19. Some Hertfordshire Well-sections. By William Whitaker, B.A., F.G.S., Assoc. Inst. C.E. 173
20. Meteorological Observations taken at Wansford House, Watford, during the year 1883. By John Hopkinson, F.L.S., F.G.S., F.R.Met.Soc. 181
21. Report on Phenological Phenomena observed in Hertfordshire during the year 1883. By John Hopkinson, F.L.S., F.G.S. 191
22. Diatoms: their Nature and Habits. By Francis Ransom. 197
23. Notes on Birds observed in Hertfordshire during the year 1884. By John E. Littleboy 207
24. Meteorological Observations taken at Wansford House, Watford, during the year 1884. By John Hopkinson, F.L.S., F.G.S., F.R.Met.Soc. 219
25. Report on Phenological Phenomena observed in Hertfordshire during the year 1884. By John Hopkinson, F.L.S., F.G.S. 227
26. Report on Insects observed in Hertfordshire during the year 1884. By F. W. Silvester, F.R.Met.Soc... .. 233
27. Miscellaneous Notes and Observations 236
28. Meteorological Observations taken at Throcking, Herts, during the year 1884. By the Rev. C. W. Harvey, M.A., F.R.Met.Soc. 239
29. Report on the Rainfall in Hertfordshire in 1884. By the Rev. C. W. Harvey, M.A., F.R.Met.Soc. 247
30. The Nests and Eggs of Birds. By Henry Seebohm, F.L.S., F.Z.S... 255
31. List of Lepidoptera observed in the Neighbourhood of Hitchin and at Knebworth, Herts. By John Hartley Durrant, F.E.S. 261

Index 267

Proceedings, November, 1883, to October, 1885, pp. ix-lxxii.

[To be inserted, in binding, before the 'Transactions.']

LIST OF ILLUSTRATIONS.

PLATES.

I. Sketch Map of part of North Hertfordshire .. *To face* p. 33
II. Section through Ashwell and Bygrave .. .. ,, 40
III. Sections of Hertfordshire Boulders .. .. .. ,, 47
IV. ,, ,, ... ,, 51
V. ,, ,, ... ,, 53
VI. Discostomatous Protozoa .. .. ,, 95
VII. Evolution of Types on Ancient British Coins. *Between* pp. xxvi and xxvii.

WOODCUTS.

Ancient British Coins .. .. p. xxxi
,, ,, ... xxxii
General Section at Mr. Lines' Brickyard (George's Farm), near Rush Green, 1 mile E.S.E. of Hertford lxvii

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,, 3.	,, 95-142	December, 1884.
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PROCEEDINGS

OF THE

HERTFORDSHIRE NATURAL HISTORY SOCIETY.

Ordinary Meeting, 20th November, 1883, at Watford.

Professor Attfield, Ph.D., F.R.S., F.C.S., Vice-President, in the Chair.

Mr. Frederick Fisher, M.R.C.S., King's Langley, was elected a Member of the Society.

Mr. John P. Bickersteth, Grove Mill House, Watford; Mr. Stephen Camp, High Street, Watford; and Mr. T. Mark Hovell, F.R.C.S., Boreham Holt, Elstree, were proposed as Members.

The following Lecture was delivered:—

"On Meteorology and some Connected Subjects." By G. J. Symons, F.R.S., Sec. R.Met.Soc.

Mr. Symons commenced his lecture by referring to the knowledge of meteorological phenomena which existed in remote ages. There was, he said, a prevailing notion amongst some people that meteorology was in its infancy, but he did not think that it was quite so young as was often imagined; and he quoted passages from Scripture with reference to the movements of the wind, the running of rivers into the sea, and the formation of snow, and further enlarged upon books by Aristotle and others of early date having reference to meteorology.

After alluding to the circular movements of the wind, Mr. Symons exhibited a new pattern of electrical thermometer made by Casella, of Holborn. It was a Six's pattern thermometer, with indices which could be set by a magnet to any required limits of temperature, high or low, and when those points were reached, contact was made and a bell rung—thus for the regulation of temperatures in hospital wards, in public buildings, greenhouses, and even as a fire alarm, the instrument was very useful, and being hermetically sealed, it was not liable to deteriorate. He then touched upon the subject of ball lightning, and said that many extraordinary tales had been related respecting it, and not a few believed them to be imaginations. Some years ago a singular case occurred in Bedfordshire;

a house was struck by lightning, and a servant, who was in one of the rooms on the ground floor, was terribly horrified at seeing a ball of lightning. She rushed out of the room, and through a passage. The ball followed, and passed her, and went into a room where it burst with a tremendous report. He mentioned that case solely as illustrative of the extremely slow motion which is a frequent characteristic of ball lightning. As to lightning, a large number of persons believed that it came from the clouds to the earth, whilst others thought differently. It had lately been urged that the motion of a flash of lightning was too rapid for the human eye to be sensible of its direction. Mr. Symons did not agree with this view, but considered that the above were matters worth the attention of members of the Society.

With respect to imagination, there were wonderful stories told of things being photographed on the human body when people had been struck by lightning. There was one of an Italian lady who, when near a geranium that was on a window-sill, was struck by lightning, and an imprint of that flower was afterwards found on her arm. Another story was that of a flock of sheep grazing in a field near Bristol. They were gathered under a tree, and a flash of lightning killed them. Upon their being skinned, marks of trees and a view of the surrounding country were supposed to be visible, and the skins were publicly exhibited. Recently a boy was struck by lightning whilst outside a shed, and the print of a yew tree was said to exist on his arm, but fortunately the arm was photographed and the mark proved to have had nothing in common with the yew tree, but to be ramified like the well-known breath-figures. The Americans had on the top of one of their mountains a meteorological observatory, and one of the persons there was struck by lightning and a mark of a tree (?) was found on his arm, yet there was no tree whatever on the mountain—tolerably strong evidence that neither trees nor photography have anything to do with such markings. Ramified figures are produced, but they are entirely independent of surrounding objects.

In dealing with thunderstorms it was necessary to allude to what were commonly known as thunderbolts. They had often heard that a thunderbolt had been found. One he heard of had made a hole in a heap of rubbish and was taken out. It was a large nodule of iron pyrites, but he did not for one moment wish to suggest that the iron came down with the lightning.

As regarded hail, they had various opinions as to its formation before reaching the earth, and he would ask those present to read an extract from the 'Monthly Meteorological Magazine' for December, 1882. He had brought for the use of the members of the Society some copies of a paper giving an account of a hailstorm at Ober Grainau, Bavaria, on June 4th of last year. They would see that Colonel Ward had been devoting considerable attention to the forms of hail, and the illustrations would prove of interest, as showing the difficulties of satisfactorily explaining the formation of the many varieties which had been engraved.

The erection of flood-marks afforded information especially valuable to engineers, and should be advocated by all natural history societies. The work might be easily done, but he did not think there were more than 500 or 600 such marks in this country. He did not himself know of 100. He felt sure that if there were ten times that number, they would prove extremely useful, especially to corporate bodies. A mere cut in a brick wall with the date and a horizontal line was good; if cut in a special stone, it was better; but engraved on a brass plate sunk in a stone was the best of all. The two following are on brass plates on the side of a door at Warrington :—

St Swithin 1828

ST THOMAS DAY 1837 WATER MARK

Another in the same town runs :—

H. W. 1828 ———

The lecturer preferred :—

X——— July 1875 ———X

but considered the precise form to be immaterial.

The question of determining the height of water in wells had received very little attention up to the present time, and the plan of recording temperature in wells should be more generally adopted, as it gave most useful information.

In the earlier part of his notes he had referred to whirlwinds, and expressed the opinion that if a whirlwind came across London in a certain direction, the roof of Charing-Cross Station would be carried into the Strand. When whirlwinds did come across the country, they were extremely narrow, whilst their track was seldom long. What was wanted was to get all the information they could as to the direction in which they travelled. Then there was the power of the whirlwind, and people would scarcely credit what tremendous force there must be when a whirlwind passed along. He had seen slates from a roof carried some distance and then driven into a tree, and sticking into it like the blade of an axe, and slated roofs weighing many tons transported bodily.

Some people did not believe in showers of frogs and showers of fish, but they were quite true and easily explained. For instance, a few years ago a heavy whirlwind passed near Banbury, and in one of the ponds there, nearly every drop of water, together with the fish, was whirled into the air, carried some distance, and then dropped on a grass field.

The altitudes of the country were being now ascertained, and before long the Ordnance Survey of England would be finished. They had a great many railroads and canals in England, and their

levels were known approximately, but at present this knowledge was scattered and difficultly accessible. He was aware that the Hertfordshire Natural History Society had set the good example of publishing many of the Ordnance Levels: he thought that they might go further, and that other Societies should follow in their steps. A contoured model in relief (and coloured geologically) of the area occupied by it would be a useful and valuable adjunct to every field club.

Referring to railways, they could not forget the terrible disaster to the Tay Bridge. It was evident that the intensity of the wind at that height was not known. At the present time engineers said that if they knew the force of wind at a particular height, it would be worth thousands to them, and his advice would be to let those who were desirous of studying that question have the thousands. Some persons were now engaged in ascertaining the velocity of the wind by an enormous kite, to which small anemometers and other instruments were attached, and he, for one, trusted that something would be discovered as to the increase of wind-force with elevation.

After referring to the efforts of Sir William Siemens, with respect to discovering the heat at considerable heights above ground,* Mr. Symons mentioned the work that was now being carried on at Ben Nevis, and, giving several anecdotes connected with the ascents of that mountain, he said he wished his Scotch friends all success in their efforts. Their work was, of course, of a troublesome character, and it was doubtful how far they would obtain scientific results. An observatory had been built in France at a great height, and various instruments fixed, but the hoar-frost was so thick that it was a question whether the records had not been thereby utterly vitiated. He thought it evident that the exact temperature could not be obtained when even telegraph-wires were covered with hoar frost several inches thick.

As to the question of forecasts, the great bulk of our storms came from the Atlantic, and unfortunately we knew very little of what was going on in the meteorology of the Atlantic. The real requisite was observations from a station 500 or 600 miles off the west coast of Ireland. Of course, that would have to be done by means of a ship moored in the Atlantic where the sea was nearly two miles deep. It was much to be deplored that that was not done, but he believed that it would be and that successful electrical communications between the ship and the land could be maintained. Such a plan would prove most important to mariners. The Trinity House, which was considered to be one of the most thoroughly scientific establishments extant, had gone into the question very carefully, and experiments were now being tried in that direction.

Another subject he wished to deal with was that of keeping true time. Of course, to have a clock that would be always correct required care and trouble, but not to such an extent as some people thought. To every postal telegraph office in England the correct time was signalled at ten o'clock every morning, therefore the

* 'Proc. Royal Soc.,' No. 226, 1883.

public would have little or no difficulty in setting their clocks at Greenwich time every day. The value of correct time to all scientific men could not be over-estimated. It was especially useful in telling almost the exact second a star was observed to shoot, and thereby improving the determinations of their paths; it was indispensable if we were to learn anything as to the foci and rates of transmission of earthquake shocks, and in many other matters. As to earthquakes, he remembered one in 1852, and he thought that more than half a dozen slight shocks had been felt in England since that date; therefore this suggestion as to their careful observation was not so superfluous as some might imagine.* Accurate time was also indispensable for comparable observations of the aurora borealis, and in mentioning it he ought not to pass in silence the splendid work which Prof. Lemström had been doing in the Arctic circle. He was now again in Northern Finland, and Mr. Symons hoped to see similar endeavours made in England, so that they could have simultaneous observations of the aurora borealis.

Research should receive every encouragement. The making of more observations was not so much wanted as the working up of those already made. It was hardly any use for a person to erect a small observatory and collect a number of instruments, unless the observations made were thoroughly threshed out. The great difficulty to be experienced in the present day was to get people to think, and he strongly urged upon all those who took an interest in meteorology to think more than they did. A serious matter in connection with scientific researches in England was the absence of encouragement and prospects to those who devoted themselves to scientific work. What would be thought of a young man who went to college and spent the best part of his time in recording meteorological observations? A man who gave his attention to science, and who required to earn his living at it, would find that he could only just keep himself respectably. That was not the way to induce people to go in for science. At present they depended upon the amateur, and there was no other country on the face of the globe where amateurs did so much for science as in England. Most of them, however, had other occupations to follow, and therefore could not give that amount of thinking which was required. In conclusion, Mr. Symons expressed a hope that his hearers would do their best to carry out some of the suggestions he had ventured to offer.

* The Essex earthquake shock of April 22nd (1884) is an apt illustration of this difficulty, for the transit of the wave seems to have been so rapid that the time occupied in travelling about 250 miles is scarcely greater than the evident errors of the clocks. There are perhaps thirty records of the time of the shock, but they are so vitiated by palpable clock-errors as to render it almost hopeless to extract the truth from them.

Ordinary Meeting, 29th November, 1883, at Hertford.

Francis Ransom, Esq., in the Chair.

Mr. Samuel Barker, Sprangewell, Ware; Mr. G. C. B. Breeze, Waters Place, Ware; and Mr. Daniel Peirson, Ware Road, Hertford, were proposed as Members of the Society.

The following paper was read:—

"The Diatomaceæ, with special reference to species found in the neighbourhood of Hertford." By Isaac Robinson. (*Transactions*, Vol. III, p. 1.)

The paper was illustrated by illuminated drawings prepared by Mr. F. W. Phillips, F.L.S., and the author.

Ordinary Meeting, 18th December, 1883, at Watford.

George Rooper, Esq., F.Z.S., Vice-President, in the Chair.

Mr. Samuel Barker, Sprangewell, Ware; Mr. John P. Bickersteth, Grove Mill House, Watford; Mr. George C. B. Breeze, Waters Place, Ware; Mr. Stephen Camp, High Street, Watford; Mr. T. Mark Hovell, F.R.C.S., Boreham Holt, Elstree; and Mr. Daniel Peirson, Ware Road, Hertford, were elected Members of the Society.

The following resolution, on the proposition of the Chairman, seconded by Mr. John Hopkinson, was then carried:—

"That as a tribute of respect to the memory of our late Treasurer, Mr. Sydney Humbert, this meeting do now adjourn."

The meeting was adjourned to the 10th of January at St. Albans.

Ordinary Meeting, 10th January, 1884, at St. Albans.

Frederick George Lloyd, Esq., in the Chair.

Mr. Edward T. Burr, High Street, Watford, and Mr. Charles R. Humbert, Denham Lodge, Watford, were proposed as Members of the Society.

The following papers were read:—

1. "The Recorded Occurrences of Land and Fresh-water Mollusca in Hertfordshire." By W. Denison Roebuck, F.L.S., and John W. Taylor. Communicated by John Hopkinson, F.L.S. (*Transactions*, Vol. III, p. 10.)

2. "Remarks on the Land Mollusca, with reference to their investigation in Hertfordshire." By John Hopkinson, F.L.S., F.G.S., F.R.M.S. (*Transactions*, Vol. III, p. 17.)

3. "List of Land and Fresh-water Mollusca observed in Hertfordshire." By Ada Selby; J. Gwyn Jeffreys, LL.D., F.R.S., F.L.S., F.G.S.; W. S. A. Griffith, F.R.C.S. (communicated by A. F. Griffith, M.A.); and Alfred T. Brett, M.D. Compiled by John Hopkinson, F.L.S. (*Transactions*, Vol. III, p. 29.)

Land Mollusca collected in the neighbourhood of Watford and St. Albans were exhibited by Mr. Hopkinson, and Land and Fresh-water Mollusca collected in the neighbourhood of Sandridge, were exhibited by Mr. Griffith. Copies of the Conchological Society's 'List of British Land and Fresh-water Mollusca' were distributed by Mr. Hopkinson amongst the members present.

Ordinary Meeting, 15th January, 1884, at Watford.

Professor Attfield, Ph.D., F.R.S., F.C.S., Vice-President, in the Chair.

Mr. Edward T. Burr, High Street, Watford, and Mr. Charles R. Humbert, Denham Lodge, Watford, were elected Members of the Society.

The following papers were read:—

1. "Notes on Boulders and Boulder-clay in North Hertfordshire." By H. George Fordham, F.G.S. (*Transactions*, Vol. III, p. 33.)

2. "On the Microscopic Structure of Boulders found in the North of Hertfordshire." By J. Vincent Elsden, B.Sc., F.C.S. (*Transactions*, Vol. III, p. 47.)

Mr. F. H. Berry and Mr. F. G. Lloyd were elected auditors of the accounts for 1883.

Ordinary Meeting, 24th January, 1884, at Hertford.

A. F. Buxton, Esq., Vice-President, in the Chair.

Miss Horn, Thundridge Vicarage, Ware, was proposed as a Member of the Society.

The following lecture was delivered:—

"On Deneholes." By F. C. J. Spurrell, F.G.S.

Anniversary Meeting, 19th February, 1884.

(At Watford.)

John Evans, Esq., D.C.L., LL.D., F.R.S., F.S.A., F.L.S., F.G.S., Vice-President, in the Chair.

The Chairman announced that the President of the Society, Earl Cowper, K.G., was unavoidably absent from illness. He had prepared an address for this meeting which he hoped to deliver at the next Anniversary Meeting. In the President's absence, he (Mr. Evans) would say something on a subject he had treated of elsewhere some years ago, for, having only known the previous day that he might be called upon to deliver an address on this occasion, he had not been able to prepare anything specially for the Society.

The Report of the Council for 1883 and the Treasurer's Account of Income and Expenditure, were read and adopted.

A vote of thanks to Mr. John Hopkinson, retiring from the office of Honorary Secretary, was proposed by the Chairman, seconded by Professor Attfield, and carried.

The Chairman then delivered an Address on the Coinage of the Ancient Britons considered in relation to Natural Selection (p. xxii).

The following gentlemen were duly elected as the Officers and Council for the ensuing year :—

President.—The Right Honourable the Earl Cowper, K.G.

Vice-Presidents.—Alfred T. Brett, M.D. ; Alfred Fowell Buxton; John Evans, D.C.L., LL.D., F.R.S., F.S.A., F.L.S., F.G.S., etc.; William Ransom ; George Rooper, F.Z.S. ; C. E. Shelly, B.A., M.B.

Treasurer.—Charles R. Humbert.

Honorary Secretaries.—Richard B. Croft, R.N., F.L.S., F.R.M.S., and Frederick George Lloyd.

Librarian.—Allan Barraud.

Curator.—William Verini.

Other Members.—Professor John Attfield, Ph.D., F.R.S., F.C.S.; the Rev. Canon Bradby, D.D.; F. Haycraft Berry, M.B. ; Frank M. Campbell, F.L S., F.Z.S.; F.R.M.S.; E. M. Chater; Alfred J. Copeland; John Hopkinson, F.L.S., F.G.S., F.R.M.S., F.R.Met.Soc.; John E. Littleboy; F. W. Phillips, F.L.S. ; Frank W. Silvester, F.R.Met.Soc.; Rev. E. T. Vaughan, M.A.; John Weall.

The thanks of the Society were then accorded to Professor Attfield and Mr. F. M. Campbell retiring from the office of Vice-President; and to Mr. Arthur Cottam, the Rev. C. W. Harvey, M.A., and Mr. W. Lepard Smith retiring from the Council.

Report of the Council for 1883.

In presenting the Ninth Annual Report, the Council of the Hertfordshire Natural History Society and Field Club can again congratulate the members upon the amount of work done in the investigation of the Natural History of the County, the number of valuable papers and lectures which have been read or delivered at the evening meetings, and the continued interest taken in the meetings in the field.

During the year twenty-five ordinary members and four honorary members have been elected ; five members have compounded for their annual subscription ; thirteen members have resigned ; and the Council regrets to have to record the loss of four members by death—Mr. George Brightwen (a life-member), Mrs. Joseph Hill, Mr. Sydney Humbert, and Dr. F. H. Wilson Iles.

Two years ago Mr. Sydney Humbert was elected Treasurer of the Society, and by his death the Society has lost a most able officer and valued member. The position of Treasurer is one which requires methodical business habits in keeping the accounts, and energy and tact in collecting the subscriptions, especially those of

members in arrears; and Mr. Sydney Humbert performed these duties most efficiently. He had the welfare of the Society thoroughly at heart, and evinced his interest in it not only in the amount of attention he devoted to the work pertaining to his office, but also in his frequent participation in discussions at the evening meetings. As a mark of respect to his memory the meeting at Watford on the 18th of December, the first after his death, was adjourned after the formal business had been transacted.

The census of the Society at the end of the years 1882 and 1883 was as follows:—

	1882.	1883.
Honorary Members	15	19
Life Members	38	42
Annual Subscribers	215	219
	268	280

Five parts of the Society's 'Transactions' have been published during the year, and the present volume, containing the proceedings of the last two sessions, will be completed within the next month or two. Up to the end of last year the Society has published in its 'Transactions' 1320 pages and 10 plates, and, as the number of members has increased, so has the amount of matter published. The number of pages issued each year is as follows:—

1875 . . . 64	1878 . . . 160	1881 . . . 192
1876 . . . 96	1879 . . . 180	1882 . . . 160
1877 . . . 104	1880 . . . 156	1883 . . . 208

The following are the principal papers and lectures which have been read or delivered during the year 1883:—

Jan. 16, at Watford.—Windsor Forest and its Famous Trees; by the Rev. Canon Gee, D.D.

Feb. 15, at Hertford.—On Methods of Illustrating Lectures on Microscopic Objects; by F. W. Phillips, F.L.S.

—— 20, at Watford.—Anniversary Address; by the President, George Rooper, F.Z.S.

March 20, at Watford.—Meteorological Observations taken at Wansford House, Watford, during the year 1882; by John Hopkinson, F.L.S., F.R.Met.Soc.

—— Report on Phenological Phenomena observed in Hertfordshire during the year 1882; by John Hopkinson, F.L.S.

—— Notes on Insects observed in Hertfordshire during the year 1882; by Eleanor A. Ormerod, F.R.Met.Soc.

—— Notes on Birds observed in Hertfordshire during the year 1882; by John E. Littleboy.

—— Notes on some Hertfordshire Mammalia; by Alfred T. Brett, M.D.

—— 29, at Hertford.—Notes on the Re-introduction of the Beaver into Britain; by Augustus Hawks.

April 17, at Watford.—Some Experiments on the Physics and Chemistry of the Sap of Plants; by Professor Attfield, Ph.D., F.R.S., F.C.S.

—— Report on Flowering Plants and Ferns observed in Hertfordshire in 1882; by Ada Selby.

—— 19, at Ware.—Notes on the River Lea below Hertford; by Richard B. Croft, R.N., F.L.S.

April 19, at Ware.—Report on the Rainfall in Hertfordshire in 1882; by the Rev. C. W. Harvey, M.A., F.R.Met.Soc.
—— Meteorological Observations taken at Throcking, Herts, during the year 1882; by the Rev. C. W. Harvey, M.A.
June 1, at Hertford.—The Spiders of the neighbourhood of Hoddesdon: a Contribution to the Arachnidal Fauna of Hertfordshire; by F. M. Campbell, F.L.S., F.Z.S., F.R.M.S.
—— Notes on the Construction and Application of the Spectroscope; by C. E. Shelly, B.A., M.B.
Nov. 20, at Watford.—On Meteorology and some Connected Subjects; by G. J. Symons, F.R.S., F.R.Met.Soc.
—— 29, at Hertford.—The Diatomaceæ; with special reference to Species found in the neighbourhood of Hertford; by Isaac Robinson.

In addition to these papers several short notes were read at the meeting on the 17th of April, relating to the meteorology, botany, and zoology of Hertfordshire. A Bye Meeting for microscopical study was held on the 23rd of January at St. Albans.

The endeavour which has been made to enlist the services of recorders, whose duties are to investigate the Meteorology, Geology, Botany, and Zoology of the county, and to collect information from the members upon these subjects, has had a very successful result. Of the eighteen papers enumerated above, eight may be considered to be the reports of our recorders on various branches of the Natural History of Hertfordshire. In Meteorology, the Rev. C. W. Harvey reports upon the rainfall, and Mr. Hopkinson upon phenological phenomena; in Botany, Mr. Robinson reports upon the Diatomaceæ, and Miss Selby upon the flowering plants and ferns; and in Zoology, Miss Ormerod reports upon the insects, Mr. Campbell upon the spiders, Mr. Littleboy upon the birds, and Dr. Brett upon the Mammalia of the county. Mr. Campbell's paper on the Spiders of Hoddesdon, which has recently been published in your 'Transactions,' may be specially alluded to as a most important contribution to the fauna of Hertfordshire as well as one of great value to the natural history of the Arachnida.

The following Field Meetings have been held during the year:

April 21.—Berkhamsted and the Bourne Valley.
May 19.—Aldenham, Watford.
June 2.—Bricket Wood, Watford.
—— 16.—Berkhamsted and Brickhill Green.
—— 28.—Easneye Park, Ware.
July 7.—Cassiobury Park, Watford.
Oct. 28.—The Tunnel Woods, Watford.

Two of these meetings were held in conjunction with other societies, that on the 21st of April with the Geologists' Association, and that on the 28th of June with the Essex Field Club. The former of these was under the direction of Dr. John Evans, F.R.S., who gave an interesting outline of the history of Berkhamsted and its castle, and a succinct explanation of the geological and meteorological conditions to which the existence of the Hertfordshire Bourne and other similar intermittent streams is due. The meeting on the 28th of October was the second annual cryptogamic meeting the Society has held, and on this occasion the members had the advantage

of the presence of Dr. Braithwaite, F.L.S., Dr. M. C. Cooke, A.L.S., Mr. E. M. Holmes, F.L.S., and Mr. Worthington G. Smith, F.L.S., by whom about 150 species of cryptogamic plants were identified, including one very rare moss, *Seligeria paucifolia*.

For hospitality kindly afforded at the Field Meetings the Society is indebted to Mr. McGregor, Aldenham Abbey; to Mr. Littleboy, at Brickhill Green, Berkhamsted; to Mr. T. F. Buxton, Easneye Park; and to Mr. George Rooper, Nascott House, Watford, at the Cassiobury meeting.

In addition to these field meetings, on Saturday afternoon, the 28th of April, a visit was paid to the Zoological Gardens, Regent's Park, under the guidance of Dr. P. L. Sclater, F.R.S., Secretary of the Zoological Society, who gave most interesting lecturets on the principal Mammalia, treating of the geological and geographical range of the different families, of their anatomical differences, and their peculiar habits. His remarks were listened to with great attention, and at the conclusion of his last discourse the members present accorded to him a cordial vote of thanks. The members and their friends were admitted into the gardens free.

On Wednesday evening, the 31st of October, a conversazione was given at the Watford Public Library, by the Chairman, Mr. J. J. Smith. All the members of the Society were invited, and a room was appropriated to exhibits by them. Several members brought their microscopes, and, besides the objects thus exhibited, most of which were living, many other interesting natural objects were displayed.

In the report for 1881 it was stated that the MS. of the late Mr. R. A. Pryor's 'Flora of Hertfordshire' had been entrusted to Mr. James Britten, F.L.S., who had undertaken to edit it for the Society. It having recently been ascertained that no progress had been made with the work, the MS. has now been transferred to your Secretary, Mr. Hopkinson, who has secured the services of Mr. A. E. Gibbs in transcribing it and assisting him in its preparation for the press. Mr. Pryor's botanical views differed so materially from those of the majority of our English botanists, especially in the vexed questions of what constitutes a variety, a sub-species, a species, and a genus, that it is impossible to bring out the work in conformity with the nomenclature of any existing British Flora, and as some portions of the MS. appear to express his latest views, while others do not, and there is much that the author evidently only intended for his own reference, although no indication is given as to what he intended to be printed and what to be omitted, the work of editing will be an arduous undertaking, and will occupy a considerable time. An introduction on the physical features of the county considered in relation to the distribution of its plants has also to be written.

The Society's Library continues to receive considerable accessions by donation and exchange, but it is not made use of by the members to the extent that might be anticipated from its value. This is probably partly due to the want of a complete catalogue, and partly to the want of sufficient space to render the books easily accessible.

Some of the books have had to be placed in two rows one behind the other on the shelves, and others are packed away in cupboards. It was stated in the report for 1882 that the Council had decided that a new catalogue should be prepared. This is now nearly ready for the press and it will probably be issued with the concluding part of the present volume of the 'Transactions.' It will contain all books and bound volumes of pamphlets in the possession of the Society at the present time. Its preparation has taken longer than was anticipated, chiefly owing to the difficulty of getting the books arranged in the limited space available. The permission of the Public Library Committee has now been obtained for the Society to place a third book-case in the Lecture Room, which will enable all the books at present in the possession of the Society, except the publications of Societies, to be placed in the room in which your meetings are held, and arranged for convenient reference.

The cabinet of microscopic objects at Watford has received the following accessions:—52 slides by subscription to Mr. Cole's 'Studies in Microscopical Science,' 27 slides of sections of Hertfordshire boulders presented by Mr. J. Vincent Elsden, and 24 slides of sections of vegetable tissues presented by Mr. Bernard Piffard.

The financial position of the Society continues to be most satisfactory. The expenditure has been £14 11*s.* 8*d.* less than the ordinary receipts, and the sum of £25 has been received for life-compositions, thus increasing the entire funds of the Society from £314 17*s.* 10*d.* at the end of 1882, to £354 9*s.* 6*d.* at the end of 1883, which amount comprises £198 15*s.* 6*d.* invested in Consols, £100 at the London and County Bank on deposit account, and £55 14*s.* 6*d.* on current account. £215 having been received for life-compositions, and there being an unexpended balance of £48 11*s.* from the late Mr. R. A. Pryor's bequest, the accumulated balance of nine years' ordinary receipts over expenditure thus amounts to £90 18*s.* 6*d.* The following is a *resumé* of all the balance-sheets to the end of 1883:—

RECEIPTS.

	£	*s.*	*d.*
Annual Subscriptions ...	808	10	0
Entrance Fees	124	10	0
Life Compositions	215	0	0
Sale of 'Transactions' *	12	17	11
Pryor Bequest	91	16	0
Interest on Consols and Deposit Account ...	34	18	0
	£1287	11	11

EXPENDITURE.

	£	*s.*	*d.*
Printing 'Transactions'	451	18	8
Books, Stationery, and Miscellaneous Printing	116	7	4
Library, and property purchased	105	18	7
Expenses of Meetings ...	72	7	0
Postages	110	3	6
Sundry Expenses	33	2	4
Pryor Bequest	43	5	0
Investments and Balance	354	9	6
	£1287	11	11

A similar *resumé* for the first five years was given in the report for 1879.

* On 31st December, 1883, £1 4*s.* 1*d.* was due from the Society's publisher for sale of 'Transactions,' and has since been received.

INCOME AND EXPENDITURE FOR THE YEAR ENDING 31st DECEMBER, 1883.

Dr.	£	s.	d.
To Balance brought forward	16	2	10
,, Subscriptions for 1882	6	10	0
,, ,, ,, 1883	97	0	0
,, ,, ,, 1884	5	0	0
,, Entrance Fees	11	0	0
,, Life Compositions	25	0	0
,, Dividend on £203 4*s.* 6*d.* Consols	5	19	4
,, Interest on £100 on deposit	2	10	9
,, Sale of 'Transactions'	0	6	6
	£169	9	5

Cr.	£	s.	d.
By Stationery	1	10	0
,, Printing 'Transactions'	70	17	0
,, Miscellaneous Printing	7	17	6
,, Expenses of Watford Meetings	2	17	0
,, Library	3	5	3
,, Subscription to 'Studies in Microscopical Science'	3	7	0
,, ,, ,, Objects for the Microscope	1	1	0
,, Salary of Assistant	6	0	0
,, Postages	15	2	6
,, Cheque Books	0	4	2
,, Sundry Small Expenses	1	13	6
,, Balance at Bank	55	14	6
	£169	9	5

To amount invested in the purchase of £203 4*s.* 6*d.* Consols ..... £198 15*s.*
,, ,, on deposit at the London and County Bank ..... 100 0*s.*

Audited and found correct, this 15th day of February, 1884, { F. H. BERRY, M.B.
F. G. LLOYD.

Your Secretary, Mr. Hopkinson, resigns, having held the office of Secretary and Librarian from the formation of the Society in January, 1875, to the end of 1879, and the office of Secretary, jointly with Mr. Croft as Secretary for East Herts, from 1879 to the present time. The members of the Council, on the occasion of Mr. Hopkinson's retirement from the post of Secretary, desire to place on record their high appreciation of his devoted labours on behalf of the Society during a period of nine years. They cannot but feel that the present prosperity of the Society is in the main due to the careful and efficient manner in which he has performed the arduous duties of his office.

In conclusion the Council has to express the thanks of the Society to the Committee of the Watford Public Library for the accommodation afforded for your library and the Watford meetings, and also to the members of the Hertford Literary and Scientific Institution for the continued free use of their rooms for the Hertford meetings.

ANNIVERSARY ADDRESS.

By John Evans, D.C.L., LL.D., F.R.S., F.S.A., F.L.S., F.G.S., Vice-President.

Dr. Evans said that he rose to address the Society under circumstances of very considerable difficulty, as it was not until the previous day that he had the faintest idea of taking the place of their President, and those who assembled would expect to hear an Address of some kind from whoever occupied the chair.

The Report of the Council had already given the meeting a good and accurate *résumé* of what had been the work of the Society during the past year, and it appeared to him that it would only be a waste of time if he were to try to dwell upon the details already laid before them. He might, however, congratulate the Society upon the continued success of those who were labouring to investigate the natural history of this county, and on the extreme accuracy and detail which appear in the various reports published in the 'Transactions.' He was glad also to find that some of those branches of natural history which in previous years had hardly received the amount of attention to which they were justly entitled, as, for instance, the Cryptogamic Flora and the Mollusca of the county, were now being diligently investigated, and he hoped would shortly be fruitful sources of communications to the Society. He had no doubt that during the present year interesting papers would be communicated to the Society, and trusted that the attendance at the meetings on this side of the county might be larger than had been the case on various occasions. It was of course not a fair compliment to the authors of papers if they read them in a room where there were very few to listen to them, and he thought it the duty of the members who did not contribute papers themselves to attend the meetings to hear the papers of other members.

He was there, as they saw, occupying the presidential chair, and, he believed, called upon to give a presidential address. But it would be hopeless for him, at something less than thirty-six hours' notice, to attempt to give anything that would be worthy of their attention from a natural-history point of view. He had therefore looked among such papers as he had by him to see if he had anything which might be suitable to give to a society mainly interested in natural history. He had heard of the unfortunate clergyman who, having to preach on behalf of an infirmary, went to his store of sermons, and found one which began by recommending liberal giving, but when he got to the middle of his sermon discovered that he was preaching rather on behalf of a new organ than an infirmary. He should not, however, fall into an error of that kind, though the subject upon which he proposed to address them might not at first sight appear to be one strictly adapted to a Natural History Society. His subject was one on which he had already addressed the Royal Institution in London, some nine years ago—"The Coinage of the Ancient Britons, and Natural Selection."

This Society had extended its bounds to some extent so as to embrace Pre-historic Archæology, but how far the Coinage of the Ancient Britons came within the limits of Pre-historic Archæology he would not venture to determine. It might be said at the outset that there did not appear to be any close connection between the coinage of any country and the theory of natural selection. He hoped, however, even if they did at the first fail to find any connection of that kind, that some slight sketch of the early history of our country, so far as the coinage is concerned, at a time when it had not as yet been brought under the Roman yoke, might not be altogether uninteresting. If in addition he should be able to show that the succession of the types of the Ancient British coins followed certain laws, to a great extent analogous with those by which the evolution of successive forms of organic life appear to be governed, the two subjects would no longer appear to be incongruous. Should he go on to show that a recognition of the successive stages of development in the coinage was absolutely necessary for its being properly understood, and for placing the various coins in even approximately chronological order, it would be seen that instead of a want of coherence, there was, in fact, an intimate connection between the two portions of the subject.

Coins are excellent indiciæ of the state of civilization of any country. They exhibit the condition of the arts, especially with regard to the production of metals, and metallurgy, as well as the skill of the engravers. They also illustrate the amount of commerce as distinct from barter, for the more numerous the denominations of the coins, the greater must have been the demand for them for the daily necessities of life; while their values and proportions, as compared with those of neighbouring countries, and the character of the types upon them, may illustrate the relations of one country to those around it. The devices on the coins also frequently serve to throw a light on the history and mythology of the countries in

which they were struck. Before proceeding to describe the coinage of ancient Britain, it was thought desirable to notice some of the early accounts of this country as given by Roman and Greek historians.

The intercourse between Britain and the more highly civilized nations of Southern Europe dates back to a remote period. So early as the middle of the fifth century B.C. Herodotus excuses himself for not being acquainted with the Cassiterides from which tin was brought to the Greeks, and it is thought that these islands ought to be identified with Britain. In the middle of the fourth century B.C. Aristotle makes mention of the Britannic Isles, Albion, and Ierne; and again, in the second century B.C. Polybius apologises for not writing about the Britannic Isles and the working of tin. It is not, however, until the latter half of the first century B.C. that we obtain from Diodorus Siculus and Strabo, both of whom wrote shortly after the invasion of Julius Cæsar, some more detailed accounts of Britain, its customs and inhabitants. After giving some particulars of these latter, the speaker more especially called attention to the history of the commerce in tin, as given by these authors. Diodorus relates how, after it had been converted into ingots and carried to the island of Ictis—possibly St. Michael's Mount—it was purchased by merchants, who transported it to Gaul, through which country the tin was carried on horses by a thirty days' journey to the mouth of the Rhone. Strabo states that the tin, and lead also, were bartered for earthenware, salt, and bronze vessels, and that the traffic was carried on principally by Phœnicians from Cadiz. He it is who relates the anecdote of the Phœnician captain who, being followed by a Roman ship in order to ascertain the route to Britain, deliberately ran his vessel on a shoal, and received from the State the value of his cargo, in return for not having divulged what was then a national secret.

These relations have all the appearance of having been derived from some earlier sources, and are mainly important as showing the amount of intercourse there must have existed between the Continent and the extreme west of Britain.

With regard to the actual condition of Britain at the time of the invasion of Julius, B.C. 55, we must look to the account of the invader himself, and the supplementary notices of other authors. At that time a very considerable incursion of the warlike Belgic tribes from the Continent had taken place, driving into the interior those who by the tradition of the period were the indigenous race. In these Belgic districts the names of the towns were often the same as those of the continental homes of the settlers. The inhabitants were numerous; the buildings like those of Gaul; there was an abundance of cattle; and though some animals, such as hares, common fowls, and geese, were not eaten, they were kept for amusement. The principal products which are noticed are corn, cattle, gold, silver, and iron, skins, slaves, and dogs, such as were used by the Gauls in war. Kent was the most civilized part, owing to its contiguity to the continent.

In the interior the inhabitants did not sow corn, but lived on milk and flesh, though they did not know how to make cheese, incredible as this may appear to Welshmen. They had wives in common, and in many other respects there was a marked contrast between the tribes on the southern and south-eastern coast and those of the interior.

But though the former were so much more highly civilized than the latter, there is one remark of Cæsar which has caused many to doubt the existence of any coinage among them. The passage, as commonly received, is as follows: "Utuntur aut ære aut annulis ferreis ad certum pondus examinatis pro nummis" "They use either brass, or rings of iron adjusted to a certain weight, instead of money." It has, however, been pointed out by the late Mr. Hawkins that the passage is corrupt, and that in several MSS. there is express mention made of gold coins. But in addition to this, a letter to Cicero from his brother in Britain speaks of a tribute in money having been imposed upon the island "imperatâ pecuniâ"; and from other authors there seems reason to believe that a tribute was actually paid.

On any examination of the circumstances of the case, the absence of a coinage in Britain appears in the highest degree improbable. There was at the time of the invasion a remarkably close intercourse between Gaul and Britain. During the Gallic war a league of Gaulish tribes sent over to Britain for assistance. The news of Cæsar's intended invasion is reported to have been carried over to Britain by the traders; no less than four ports are mentioned by Strabo as those from which there was constant commerce to this country from the Continent, and Divitiacus is expressly mentioned as having held dominion over a considerable part of Britain as well as in Gaul. Other facts might be cited, but these suffice to show that if the use of coins was known in Gaul—and of this there is no question—it must also have been known in Britain. So far therefore as this passage is concerned, we must regard it either as not containing the original statement of Cæsar, or else as being based on some misrepresentation of facts.

That this is the case is proved by the testimony of the coins themselves. Throughout the whole of the southern and south-eastern part of Britain, as far as a line joining the Severn and the northern part of Yorkshire, that is to say, in those parts which were once settled by Belgic tribes, and the adjoining districts, coins undoubtedly of British origin have been found in considerable numbers.

They are of two classes, uninscribed and inscribed, and in the names, types, and inscriptions on many of those of the latter class the influence of contact with the Romans may be traced. This class may, indeed, for the most part be attributed to the period between the second landing of Julius, B.C. 54, and the conquest by Claudius, A.D. 43-44, though some are of even later date.

During this interval of rather less than a century there was much intercourse between Britain and Rome, including, of course, the

Roman province of Gaul. No doubt the annexation of Britain might have taken place at an earlier period than it did, had not Augustus purposely avoided extending the Roman Empire to Britain. More than once, however, he was induced to undertake the task, though he allowed himself to be diverted from it. On one of these occasions it was by British ambassadors, who deposited offerings in the Capitol, and are said by Strabo to have brought the whole island into friendly connection with the Romans. The Britons, indeed, are said to have agreed to pay duty on all exports and imports from or to Gaul, and this was considered preferable to garrisoning the island.

That Rome was here as elsewhere recognized as the mistress of the world was evinced by Adminius, a son of Cunobelinus the British chief, seeking refuge with Caligula, as did also one Bericus at the court of Claudius, and as had formerly another British prince at the court of Augustus.

It can therefore well be imagined that Roman a[illegible] became known in Britain, and that probably artists trained either in Italy or Gaul settled in this country. It is certainly not surpris[illegible]g to find devices borrowed from Roman coins superseding or modifying the more purely native types.

Although numerous British tribes are mentioned by early historians, it is difficult in most cases to assign particular coins to them. This is partly owing to the names of the tribes but rarely occurring upon the coins, and partly to the difficulty in assigning exact limits to their territories, which, from conquests or other causes, appear to have been continually varying.

It has therefore been thought safer to treat of the coins under the head of districts rather than of tribes. The study of this class of coins is to a certain extent like that of geology; we have no written history on which to rely, and the annals of the past have to be reconstructed from the evidence of contemporary but dumb witnesses, disinterred from the soil. With gold coins, the geographical range of which is, as is well known, wider than that of those in the baser metals, it is unsafe to argue from only one or two instances; where, however, numerous coins of any given type have been found, we are able to fix their original home, and, by means of the types, to arrive at some conclusion as to the chronological order even of uninscribed coins.

The coinage of the several districts was next described, and diagrams of various specimens exhibited, some of which are reproduced in the accompanying plate (Plate VII) *

The inscribed coins of the western district, comprising Somersetshire, Gloucestershire, and Wilts, and parts of adjoining counties, give the legends BODVOC, CATTI, COMVX, VO-CORIO, EISV, etc., which are of doubtful interpretation. There are also coins of a prince Antedrigus, of which a specimen is engraved in Fig. 7.

* The drawings are taken from Mr. Evans' work "Ancient British Coins," 8vo., 1864, to the plates of which reference is also occasionally made.

In the south-western district of Hampshire, Sussex, and western Surrey, are found coins of Commius, an Attrebatian chieftain mentioned by Cæsar, and of two of his sons, Tincommius and Verica. Many of these are executed in an artistic manner, and probably by foreign engravers.

The coins of a third son of Commius, Eppillus, are found in the Kentish district, which embraces Kent and eastern Surrey, as are also those of Amminus and Dubnovellaunus. This latter prince was among those who came as suppliants to seek aid from the Emperor Augustus, and his name is found under the forms DAMNO BELLAVNVS and ΔOMNΩN BEΛΛAYNOΣ on the celebrated monument of Ancyra. Figs. 23 and 29 show specimens of his coins.

In the central district, comprising Bucks, Beds, Herts, Middlesex, Essex, Northampton, and parts of neighbouring counties, numerous coins have been found. The principal are those of Andocomius, whose territory seems to have been in Bucks and Beds; Tasciovanus, whose capital was Verulam, now St. Albans; and his son Cunobelinus—the Cymbeline of Shakespeare—whose capital was Camulodunum, now Colchester. Coins of Tasciovanus and Cunobelinus are shown in Figs. 16 and 8, but there exists a vast variety of other types in gold, silver, and copper, many of which are distinctly copied from contemporary Roman coins.

The eastern district of Norfolk, Suffolk, and some part of the adjoining counties, appears to have been occupied by the Iceni. The coins are principally in silver, but there are gold coins of a chief Addedomaros (Figs. 10 and 11), and also some uninscribed gold coins, such as Figs. 12 and 13.

The Yorkshire district comprises parts of the adjacent counties to the south, and was mainly occupied by the Parisii. The legends on the coins, VOLISIOS, DVMNO-CO VEROS, VEP. CORF, etc., have as yet defied interpretation. Some coins from this district are shown in Figs. 26, 27, and 28.

Taken as a whole, the series of inscribed coins bears witness to a considerable degree of civilization prevailing in Britain, especially in the parts most nearly adjacent to the Continent. Not only are these numerous and varied types skilfully engraved, but the different denominations of the coins show that the requirements of trade were by no means inconsiderable. Taking, for instance, the currency under Tasciovanus, we find a larger gold coin, weighing about 84 grains, and a smaller, representing one quarter of its value. There is but one denomination of silver coins, a small piece weighing about 20 grains. In copper, however, there are coins of three sizes, intended to weigh about 68, 34, and 17 grains respectively. So that about the Christian era there were current at Verulam, for the purposes of internal trade, no less than six denominations of coins.

The second class of coins, the uninscribed, occur also in the three metals, gold, silver, and copper, as well as occasionally in tin.

In many cases they appear to have been current at the same time as the inscribed coins, as they occur in the same hoards; but for the most part they appear to belong to an earlier date. In some

parts of Britain, however, there does not appear to have ever been an inscribed coinage. Among the gold coins, and not unfrequently among those in the other metals, there is a great general similarity of type on one or both faces. On the obverse there is usually a wreath in some form or other, and on the reverse a horse more or less distinctly portrayed; and this circumstance at once points to a derivation of the different varieties of type from some common source.

Two questions are therefore suggested: 1. What is this prototype or source? And 2. What are the laws which seem to govern its modifications?

Fortunately the prototype of many of the derivations is readily to be recognized in the coins like Figs. 2 and 3 in the Plate, which are found over the whole of the south-east of Britain, though they would appear to be most abundant in Kent. The parentage of this British prototype can also readily be traced. There can be no doubt of its being a descendant from the Philippus—the gold *stater* of Philip II. of Macedon.

Nor is it difficult to see in what manner a type from so remote a country as Macedonia travelled to Britain. The close intercourse between this country and Gaul has already been mentioned, and in Gaul a coinage had existed for several centuries B.C. The knowledge of the art of coining seems to have been introduced from Massilia—now Marseilles—a Phocæan colony founded about B.C. 600, and from other Greek colonies founded in the south of France. The silver coins of Massilia were at an early period imitated in the surrounding districts, but until the latter half of the fourth century B.C. the currency of gold coins among the Greeks was limited in extent.

About B.C. 356, however, the gold mines of Crenides or Philippi were acquired by Philip II., and were soon made to yield an amount of gold equivalent to nearly £250,000 per annum. An enormous extension of the gold coinage was a natural result, and the *staters* of Philip became current all along the coasts of the Mediterranean, and were soon seized on as objects for imitation by those who, like the Gauls of southern France, were on the borders of Greek civilization. The extension northwards through Gaul must soon have followed, and the transition thence into Britain was a natural consequence.

Though intermediate types exist between the Philippus, Fig. 1, and what is termed the British prototype, Figs. 2 and 3, it is needless to adduce them, the modifications which the types have undergone not preventing their original identity from being apparent, though they are by no means inconsiderable in extent.

On the obverse the laureate head of Apollo, or, as some have thought, of the young Hercules, has received additions in the shape of a bandlet round the head and a gorget on the neck, not improbably to give it the attributes of some more purely Gallic divinity. The wreath and hair have been reduced into a regular system, the back hair being rendered by a series of flowing locks all of one pattern, and the front hair by three open crescents. On the reverse,

which originally commemorated the victories of Philip at Olympia, the charioteer has grown wings, but the body, fore-arms, and whip have become represented by a series of dots or pellets, the wheel of the chariot only at times survives, and the two horses have become amalgamated, though the legs are often bifid in remembrance of the original duality of the animal. All traces of the name ΦΙΛΙΠΠΟΥ have disappeared.

Starting with this British prototype, the next question is as to the laws which regulate its farther modifications, and how they are allied to those of natural selection. It is hardly necessary to enter at any length upon the theory of evolution with which the name of Darwin will ever be associated. It is, however, desirable to give a brief summary of some of its principal features.

In successive generations of animals and plants, though the offspring as a rule absolutely resembles the parents, there is always a tendency to variation, so that forms in some degree varying from the parent form are from time to time liable to make their appearance.

If in the struggle for existence these new varieties possess any advantage over the forms already in being, they are likely to be perpetuated, though for a length of time there is a liability in their progeny to revert in the direction of the earlier form.

Even long after some organ, owing to modifications in the mode of life, has ceased to be of service to the organism, it frequently survives in an atrophied form.

Moreover, the degree in which a variety or modification is advantageous, and therefore likely to be perpetuated, is to a great extent dependent on external conditions, the changes in which afford opportunities for new forms to prove their utility.

No doubt this theory of descent with variation holds good with regard to most of the appliances of man; but it is more especially with regard to the changes in the types of coins, and in other ornamental devices among people in a low stage of culture, that we can trace laws somewhat analogous to those of natural selection. To the evolution of culture General Pitt-Rivers has devoted especial attention, and the present discourse is restricted to one special class of coins, though similar results to those which are found in Britain might be observed in the early coinage of some other countries.

The necessities of the case with regard to coins are: 1. That the successive issues or generations of coins should resemble each other sufficiently to pass current together; but, 2. Art being imperfect, there must have been more or less important variations and modifications in the successive dies which were engraved. This tendency to variation was increased by the necessity of the dies being rather larger in diameter than the coins which were struck from them, so that the new dies were often copied from coins not showing the whole of the device. They were also frequently copied from coins worn by circulation, and in many instances the external influence of the introduction of foreign artists made itself powerfully felt. 3. When not disturbed by this foreign element, the requirements

which the types had to fulfil in order to be perpetuated were, in addition to the necessary resemblance to the pre-existing types, *a*, that they should be of easy execution; and *b*, that they should present symmetry of form.

It is well known that the natural instincts of man seem to lead him in all parts of the world to the adoption of simple and symmetrical forms of ornament; while in all stages of culture the saving of trouble and the production of the greatest amount of show at the least possible expenditure of labour, is an object of universal desire.

Thus among the ancient Britons the reduction of a complicated and artistic design into a symmetrical figure of easy execution, was the object of each successive engraver of the dies for the coins, though probably they were themselves unaware of any undue saving of trouble on their part, or of the results which ensued from it.

In devices modified in the manner suggested, it may well be expected that we should find some portions of the original devices surviving in a merely rudimentary form, nor need we be surprised if from time to time we find a tendency to revert in the direction of the prototype.

The descent of some of the types of British coins was next traced by means of diagrams, some of which are reproduced in the accompanying Plate.

The principal features in the prototype, Figs. 2 and 3, are, on the obverse, the wreath, the cross-band, the gorget, the back hair (which on Fig. 2 is arranged in one row instead of two), the front hair, and the face.

The latter, being difficult of execution and near the edge of the coin, is the first part to disappear, though it often survives in a rudimentary state as a mere swelling, like that on Figs. 4 and 5. Passing by some intermediate steps, it will be seen that by the time the stage represented by Fig. 14 is reached, the head has become reduced to a somewhat symmetrical pattern. The wreath is the main feature, but runs in two directions from a central boss; the bandlet and the upper portion of the gorget form a cross line to the wreath; the back hair has been simplified into two large locks, one on each side of the bandlet; and only one crescent of the front hair survives. In another stage, two crescents back to back have come to occupy the centre of the wreath, while the cross line has become developed into a second wreath at right angles to the first, and the whole device assumes the form of a cruciform ornament, in which the human head is difficult of recognition. On an examination of Fig. 9 it will, however, be seen that three of the angles of the cross are occupied by the gorget, some locks of the back hair, and a crescent representing the front hair, all in their proper positions. In Fig. 15 the artist has thought it sufficient to fill up each of the angles with locks of the back hair; and in Fig. 16 the ornaments in the angles are a V-shaped representative of the gorget, and a crescent of the front hair, with pellets and annulets symmetrically arranged around them. Each of the four branches of the cross wreaths starts from a ring ornament, or a ring containing a pellet;

and it seems probable that the artist who executed this cruciform device was unconscious of the fact that he was engraving the head of Apollo. When once this cruciform stage was attained, farther simplification became easy, of which examples are seen in Figs. 10 and 17. Fig. 18 gives another variety, in which the centre is occupied by a circular ornament instead of the crescents; this assists in showing how the ultimate descendant from the head, a sort of four-leaved flower, as seen on Fig. 19, was developed.

In other lines of descent the wreath retained its predominance, but there was still the tendency to develop a symmetrical ornament. This is illustrated in Figs. 20, 25, 26, and 27, the two latter of which show coins from Yorkshire. Another coin from the same district, Fig. 28, retains a small part of the original device, but little altered except by enlargement, so that three locks of back hair and a small portion of the wreath suffice to fill the field.

In another line of descent the wreath survived, modified in the same manner as on the coins with the cruciform devices, and with the crescents either in the centre or at the side of the wreath, as in Figs. 23 and 24. In Fig. 29, copied probably from a worn coin, there is merely a raised band across the field, marking the portion of the wreath; and in Fig. 22 the field is perfectly plain but convex, though the reverse is identical with that of Fig. 21, which shows the head on the obverse.

In another class of coins, which belong to the eastern district, the central crescents become the principal features. These are somewhat ornamented on the coin of Addedomaros with the cruciform type, Fig. 10, but form the whole device on another coin of the same prince, Fig. 11. In Figs. 12 and 13 other symmetrical modifications, with large crescents in the centre, are shown.

On other coins, as on those of the western district, the wreath alone is preserved, but in a form somewhat resembling a fern leaf (see Figs. 6 and 7). On the coins of Cunobelinus, when Roman art had attained great influence in Britain, it reappears as an ear of bearded corn.

On the reverses of the coins the fact of the device being a horse was rarely forgotten, although it came to be represented in a curiously disjointed manner, which saved the engraver much trouble. In Fig. 28 this conventionalized horse has its peculiarities perhaps carried to an extreme. In Fig. 5 another variety is shown, in which great importance seems to have been attached to the representation of the four legs. This form prevailed in Dorsetshire and the neighbouring counties. In most cases, however, when the artist who engraved the dies possessed sufficient skill, there was a reversion towards the original horse.

A remarkable metamorphosis of the horse is illustrated in the woodcut given above. The upper figure shows a derivative from the type of the charioteer, which can be traced through 'Evans,' Pl. E, 9, and allied coins up to 'Evans,' Pl. D, Nos. 3 and 4, though

several of the links are missing. When the type was placed before a Roman engraver, it must have been difficult for him to understand its meaning. The general resemblance to a full face with wings above is, however, evident, and there can be but little doubt that some classical artist reproduced it as the head of Medusa on the coin engraved below. One thing is certain, that the coins of the two types are found together.

On another descendant of the Philippus not shown in the Plate, the wreath and hair become represented by a series of diverging lines, and from a coin of this kind it appears probable that the vine-leaf on the coins of Verica ('Evans,' Pl. II, 9) was derived. Such a complete change of the human head might appear incredible, but there are other instances.

The close resemblance of the types of the first two coins in the annexed cut is evident, though the general device is in one case turned to the right and in the other to the left. The third coin shows that the device on the second is a boar, and on turning the page round at a right angle it will be seen that on the first is portrayed a human head in profile. These are silver coins from the eastern district.

It was thought needless to show the derivation of numerous types of coins belonging to the latter part of the series from Roman originals; and the bearing of the development of type upon the classification of the coins was next discussed.

As a rule those most distant from the prototype in character are the latest, though, of course, regard must be had to the locality to which the coins belong, as the districts nearest Gaul were exposed to different conditions from those more remote.

But, beside the succession of types, there is another important guide, which also results from a law that appears to be natural to all absolute governments which strike coins, if not indeed to other ruling powers. This is the great law of effecting economy at the expense of others, which is carried into effect by striking coins of the same denomination as those already in circulation, but either of less weight or of baser alloy, or both.

In England we have been fairly free from the operation of this law, but our silver penny weighs but $7\frac{1}{4}$ grains, instead of the real "pennyweight" of 24 grains. In Scotland, however, before the Union, the diminution in weight had been carried so far that the pound Scots was the equivalent of only one shilling and eightpence English. But for the successful application of this law the palm must be awarded to France, where the franc or livre, and its parts, the sou and denier, are direct descendants from the same stock as our £. *s*. *d*.

We have already seen how in many respects the ancient Britons were far removed from that barbarism with which they are so

commonly credited, and certainly they understood that part of the art of government which relates to a tampering with the currency remarkably well.

The coins which have been termed the British prototypes are of remarkably fine gold, and weigh from 110 to 120 grains, the weight of the original Philippus being about 133 grains. Those which come nearest to this prototype, as, for instance, those of the types Figs. 4, 5, and 20, usually weigh from 95 to 100 grains. Coins like Figs. 14, 21, and 22 are commonly about 90 grains in weight. The coin engraved as Fig. 9 weighs about 86 grains, and by the time the cruciform ornament was established the weight was brought down to about 84 grains, at which point it became permanent, or nearly so, though the gold was reduced in purity to such an extent that many coins, like Fig. 27, and of analogous types, do not contain a quarter of pure gold.

It is evident that such a reduction as that from 120 to 84 grains could not have been sudden. It is far more probable that it was effected by gradual and almost insensible alterations, as is indeed suggested by the varying weights of the coins.

Taken in conjunction with the type, the diminution in weight may give some idea as to the time necessary for the changes in the coinage to have been effected. The date of the Philippus is known, as is also that of some of the ancient British coins; and we may either take the amount of time necessary for the degeneration of the Philippus to the form of the British prototype, or for the metamorphosis of this latter into some other type of ascertained date, or both these means, to assign an era for the commencement of the British coinage.

There are coins of Commius and his sons of much the same type as Fig. 21, but weighing only 84 grains; and as Commius was a contemporary of Julius, they probably date about 30 or 40 B.C.

Dubnovellaunus, again, some of whose coins are given in Figs. 23 and 29, was a contemporary of Augustus, whose protection he sought probably in B.C. 21 or 22.

Cunobelinus died about A.D. 40, and as his reign was of long duration, as was also that of his father, Tasciovanus, the date of B.C. 30 assigned for the commencement of the rule of Tasciovanus is probably not far wrong. One of his early coins is shown in Fig. 16. Its weight, like that of the coin of Dubnovellaunus, is 84 grains.

Taking a hundred and twenty years as the time necessary for the change in weight and type from the British prototype to the coins just mentioned, the date B.C. 150 would be assigned to the prototype. On the assumption that the Philippus was first imitated in the south of Gaul about B.C. 300, this would give a hundred and fifty years as the period for the change from Fig. 1 to Figs. 2 and 3.

If the reduction in weight took place at a uniform rate, and, commencing with 133 grains in B.C. 300, attained to 84 grains in B.C. 30, the weight of the prototype, 120 grains, would be reached about B.C. 230; but this is probably too early. Looking, however,

at the stage of evolution to which the coinage had attained within but a few years after the invasion of Julius, there can be no doubt of the use of money having been known in Britain long before his time.

In conclusion, a hope was expressed that the value of these coins as throwing light on one of the obscurest portions of the history of this country had been made evident, as also that in their interpretation the recognition of some laws of development analogous to a great extent with those of natural selection afforded no mean assistance.

Under any circumstances, Dr. Evans trusted that a more favourable impression of our ancestors or predecessors in this country at the time of Cæsar's invasion had been created than that which commonly prevailed. He hoped they would no longer be regarded as the merest savages, "who stained themselves blue, sat under the mistletoe, and indulged in obscene rites," and who burnt the living in wicker baskets, instead of, in accordance with modern views, burying their dead in those useful articles, for the manufacture of which Britain was famous even in Roman times.

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Ordinary Meeting, 26th February, 1884, at Hertford.

C. E. Shelly, Esq., B.A., M.B., Vice-President, in the Chair.

Mr. Arthur B. Taylor, Chadwell Lodge, Ware, and the Rev. H. P. Waller, B.A., High Street, Hoddesdon, were proposed as Members of the Society.

The following paper was read:—

"Notes on the Protozoa of Hertfordshire: Section Discostomata." By F. W. Phillips, F.L.S. (*Transactions*, Vol. III, p. 95.)

The paper was illustrated by illuminated drawings executed by the author.

Ordinary Meeting, 18th March, 1884, at Watford.

George Rooper, Esq., F.Z.S., Vice-President, in the Chair.

Miss S. Horn, Thundridge Vicarage, Ware; Mr. Arthur B. Taylor, Chadwell Lodge, Ware; and the Rev. H. P. Waller, B.A., High Street, Hoddesdon, were elected Members of the Society.

The following papers were read:—

1. "Notes on Lepidoptera observed in the neighbourhood of Sandridge, Herts." By A. F. Griffith, M.A. (*Transactions*, Vol. III, p. 58.)

2. "Notes on Mosses, with an Outline of a Hertfordshire Moss-Flora. By A. E. Gibbs. (*Transactions*, Vol. III, p. 67.)

3. "Notes on Birds observed in Hertfordshire during the year 1883." By John E. Littleboy. (*Transactions*, Vol. III, p. 82.)

Ordinary Meeting, 15th April, 1884, at Watford.

George Rooper, Esq., F.Z.S., Vice-President, in the Chair.

The following papers were read:—

1. "List of Flowering Plants observed in Hertfordshire during the year 1883." By Ada Selby. (*Transactions*, Vol. III, p. 101.)

2. "Report on Insects observed in Hertfordshire during the year 1883." By F. W. Silvester, F.R.Met.Soc. (*Transactions*, Vol. III, p. 91.)

3. "Notes on some Scolecida." By Alfred T. Brett, M.D.

4. "On the Poisonous Effects of the Common Yew." By Alfred T. Brett, M.D.

Dr. Brett gave the following recent instances of the poisonous effects of the common Yew, *Taxus baccata*:—

In January ten steers broke into a plantation at Aldenham in the night, where several young yew trees were growing. At seven o'clock the following morning one steer was found dead, one died an hour afterwards, and another died on the third day. The other seven were very ill, and the hair on the chest and neck turned almost black. At a *post-mortem* examination made by Mr. Flitt, leaves of the yew were found in the stomach. Early in the present month (April) Mr. Flitt also attended a case of yew-poisoning at Leavesden, in a short-horn heifer, which, however, recovered in a few days. The yew tree was nearly out of reach, and only a few leaves had been eaten. In this month also a cow, belonging to Mr. A. H. Hibbert, was poisoned by eating leaves of the Irish yew, which, after death, were found in its stomach.

Dr. Brett had also heard, at different times, of the death of three horses from eating yew, one having eaten dry cuttings and the others fresh leaves. He thought that there was something in the effects of the yew which required explanation, for in many cases cattle had access to yew trees and were not poisoned. The tree being so common, it was, he thought, strange that cases of poisoning were not more numerous, and he suggested that there might be different varieties of *Taxus baccata*, some of which were poisonous and others not so, or that, as the yew is diœcious, one sex only might be poisonous. In answer to his enquiry as to the present state of our knowledge of the poison of the yew, Professor Attfield had sent him the following notes:—

"I do not know of any case of poisoning by yew in Hertfordshire prior to

the recent one at Aldenham, to which you draw my attention. I alluded to yew poisoning in my lecture on 'Poisons' at our Natural History Society five years ago, and the subject was discussed afterwards. Had any Hertfordshire case previously been published, some of the speakers would probably have known of it and have cited it. There can be no doubt that both the common yew and the Irish yew are poisonous. The poison has, in fact, been isolated, but has not yet been thoroughly investigated. So far, the evidence points to the existence in yew of an oily or oleo-resinous acrid principle similar to that of savin, and a toxic principle similar to that of foxglove. Mixed with food a few leaves may do no apparent harm to animals; taken soon after other food, also, the risk of injury is diminished. But a certain quantity, especially if taken into a more or less empty stomach, is liable to produce fatal results. With regard to the fruit, children often freely partake of it without harm, so that the pulp of the pretty berries is harmless; and possibly a few of the black seeds of the fruit might not do harm if swallowed whole, for they might pass through the system without being acted on by the digestive fluid. But they contain poison, and, if crushed in chewing, might prove as harmful as the leaves. It has been said that the leaves are more active in the spring than at other seasons of the year, but further evidence is required on this point, as on most others of this interesting subject. Unfortunately this evidence is not now likely to be forthcoming, at all events not from Englishmen. Not only do we not yet know what antidote to administer to save the life of a child who has chewed up a quantity of yew berries, stones and all, but we are not likely to know, for a well-meaning but misguided community, yielding to the clamour of a few agitators, has socially and almost legally stayed the hands and brains of those true philanthropists, who would in all mercy sacrifice the lives of a few frogs, or mice, or even dogs, in order to promote the health and save the lives of men, women, and children."

Dr. Brett then exhibited a so-called "musical mouse" which whilst on the table in a cage began to sing, much to the amusement of the members present.

Mr. Lloyd stated that he once had two "singing mice" in his possession—one died, and the other discontinued singing in about six weeks.

Field Meeting, 19th April, 1884.

PARK STREET AND FROGMORE.

Meeting at Frogmore, under the guidance of Mr. F. W. Silvester, the party crossed the meadows to Frogmore House and inspected the apiary of Mr. Burra. Having walked through the gardens, and, under the instruction of the Rev. J. Lingen-Seager, the honorary secretary of the Herts Bee-Keepers' Association, having learned a little about that useful insect, *Apis mellifica*, the party proceeded to the Vicarage.

Here the well-kept apiary of Mr. A. B. Lipscomb was examined. The hives were for the most part standing in a bee-house, and were examined at the back. The cold weather which has lately prevailed made it inadvisable to enter into anything approaching a minute examination of the contents of the bar-framed hives, but one frame was lifted out to show the structure and arrangement of the combs, and the method in which honey is stored and sealed. The exposure of a frame containing brood was, however, carefully avoided, in case it should be harmed by the cold wind. One of the

objects of a judicious bee-keeper is to keep the hive warm and maintain the heat of the brood-nest; for a chill will not only kill the brood and thus engender disease, but will prevent the laying of eggs by the queen, and thus tend to make the stock a weak one. The Rev. J. Lingen-Seager gave some practical hints with regard to the raising of queens, procuring early drones, the introduction of a new queen into an old stock, how to obtain a harvest of honey from the fruit-blossom, and other matters of vital importance to the bee-keeper. In conclusion, he alluded to the relationship which exists between bees and flowers, and their inter-dependence one on the other, illustrating the point by a reference to the two kinds of primrose known to the gardeners as the "pin-eyed" and the "thrum-eyed." It being "primrose day," many of the members were wearing bunches of these flowers, so that actual examples were easily obtainable. There was, said Mr. Seager, a prejudice amongst gardeners against "pin-eyed" primulas which arose from their ignorance of botanical science and from their not understanding the relationship of one to the other; for if there were no "pin-eyed" flowers, there would of necessity be no "thrum-eyed" ones, as one kind depends for its fertilization on the existence of the other.

The members of the Society and their friends then proceeded to the church, where a new organ has just been erected; and a short recital was given by Mr. G. Gaffe, organist of St. Albans Cathedral.

Tea was then partaken of at the Coffee Tavern, after which a meeting was held in the schoolroom, when Mr. Seager delivered an instructive lecture on bees and bee-keeping.

Ordinary Meeting, 25th April, 1884, at Hertford.

C. E. Shelly, Esq., B.A., M.B., Vice-President, in the Chair.

The following papers were read:—

1. "Meteorological Observations taken at Throcking Rectory, Herts, during the year 1883." By the Rev. C. W. Harvey, M.A., F.R.Met.Soc. (*Transactions*, Vol. III, p. 103.)

2. "Report on the Rainfall in Hertfordshire in 1883." By the Rev. C. W. Harvey. (*Transactions*, Vol. III, p. 112.)

3. "On Instinct." By F. M. Campbell, F.L.S., F.Z.S., F.R.M.S. (*Transactions*, Vol. III, p. 119.)

Field Meeting, 31st May, 1884.

RICKMANSWORTH COMMON MOOR AND MOOR PARK.

The members assembled at the principal entrance to Cassiobury Park and walked across the park to the Swiss Cottage. The course of the River Gade was then followed from the Swiss Cottage grounds to Rickmansworth Common Moor.

Here a considerable time was spent in looking for the more characteristic plants, many species which grow on the marsh-lands of the Common Moor not occurring anywhere else in the neighbourhood. Owing, however, to the exceptionally dry weather, no rain having fallen during the previous fortnight, and only about half an inch during the month, the search was not successful, the parts of the Common usually prolific in plants which require a plentiful supply of moisture being quite dry. From the same cause a diligent search for Mollusca was but scantily rewarded, scarcely any of the terrestrial forms being seen. The following species, chiefly aquatic, were collected by the Recorder of the Mollusca:—

Sphærium corneum, L.
„ *lacustre*, Müll.
Pisidium fontinale, Drap.
Bythinia tentaculata, L.
„ *Leachii*, Shepp.
Planorbis vortex, L.
Planorbis complanatus, L.
Physa fontinalis, L.
Succinea putris, L.
Helix Cantiana, Mont.
„ *rufescens*, Penn.
„ *hispida*, L.

From the Common Moor the members proceeded to Moor Park, and, after visiting some of the more remarkable trees, returned to Watford from Rickmansworth Station.

The meeting was under the direction of Mr. F. G. Lloyd.

Field Meeting, 7th June, 1884.

ALDBURY OWERS, TRING.

A small party only assembled at Tring Station at 3 o'clock with the special object of investigating the botany and entomology of the woods known as Aldbury "Owers" or "Nowers," under the direction of Mr. Bernard Piffard.

The road was first followed as far as the village of Aldbury, when a turn to the left was made into a green lane by which the woods were reached. The scarcity of Lepidoptera, noticeable in other places this year, was equally so here, and in fact no species worthy of record was captured. The weather also was not favourable; although but little rain fell in the afternoon, the morning had been thoroughly wet, and not a gleam of sunshine enlivened the day. A few interesting plants were found, not in the woods, but on the bank overlooking Tring Station, the following being the most noticeable:—

Anemone Pulsatilla, L.
Hippocrepis comosa, L.
Senecio campestris, DC.
Campanula glomerata, L.
Epipactis latifolia, All.
Orchis conopsea, R. Br.

On the same chalk banks the following Mollusca were detected by Mr. Hopkinson:—

Helix aspersa, Müll.
„ *hortensis*, Müll.
„ *Cantiana*, Mont.
Helix virgata, Da Costa.
„ *caperata*, Mont.
„ *ericetorum*, Müll.

The variety *lutea* of *Helix hortensis* was also observed.

Field Meeting, 21st June, 1884.

LEAVESDEN WOODS, WATFORD.

In the neighbourhood of Watford there is scarcely a wood which has not been selected, on one or more occasions, for a visit by the Society. Berry Grove near Aldenham, the Oxhey Woods near Pinner, the Swiss Cottage Woods in Cassiobury Park, and the Temple of Pan Woods at the Grove, have each been visited; and Bricket Wood, the Cassiobury wood-walks, the Tunnel Woods, and the Leavesden Woods, have several times been strolled through. The present occasion, however, is the first on which that portion of the Leavesden Woods which is known as the Gullett has been entered.

Assembling at Watford Junction Station, the members of the Society and their friends walked along the St. Albans road to Lea Farm, opposite to which the Gullett Wood was entered. A public footpath leads from here to Leavesden, and this was followed to near the point where the Gullett and Long Spring meet, when a deviation was made into and across the upper end of the latter wood. In the course of this walk, although nothing of rarity was found, a fair amount of botanical information was imparted, many of the younger members of the party especially being made acquainted for the first time with the names, the organisation, and the properties of the plants seen in flower, and of a considerable number of those not in flower which were identified by their leaves.

The Tunnel Woods were then visited, and by this time the party had materially increased in number. Still keeping to the woodlands, Nascott Wood was now strolled through, and soon after leaving it the grounds of Nascott House were entered. Here the members were received by Mr. and Miss Rooper, and hospitably entertained, as on two previous occasions, in 1882 and 1883. Refreshments were served on the lawn, and in the house a room was devoted to the exhibition of microscopic and other objects and scientific apparatus, lent for the occasion by members of the Society.

The meeting was under the direction of Mr. J. Hopkinson.

Field Meeting, 12th July, 1884.

RADLETT AND BATTLER'S GREEN.

Rain had been falling the greater part of the day, and was still falling somewhat heavily when the members assembled at Radlett Station, to examine the Hertfordshire conglomerate at Newberries, and "swallow-holes" near Battler's Green, under the direction of Mr. John Hopkinson. The greater number had driven from Watford, a few had come by train from St. Albans, and a very small contingent of the Geologists' Association arrived by train from London, this being a joint meeting of this Association and the Hertfordshire Society.

The road leading to Shenley was taken for a short distance, when, by permission of Mr. Thomas Bagnall, Newberries Park was entered. After walking through the grounds adjoining the house, a meadow near the park was crossed, and an opening in it not easily found revealed the only existing exposure of the Hertfordshire conglomerate.

Newberries was visited by the Society four years ago, but this is the first time the Geologists' Association has had the opportunity of seeing the Hertfordshire conglomerate *in situ*. On this occasion it was examined under by no means favourable auspices. It was necessary to walk for a sufficient distance through wet grass to add materially to the discomfort, to the ladies of the party especially, of a walk in the rain, and moreover there was no geologist present who was well acquainted with the strata of which the conglomerate forms a part—the Woolwich and Reading Series. The rain, however, now ceased, and the director of the meeting and writer of this report gave the following account of the conglomerate in its relation to the strata in which it occurs, repeating in the course of his remarks a few observations which he made on the occasion of the former visit.*

We are now, he said, as on several previous occasions when the two Societies have met together in Hertfordshire, standing on the edge of the London Tertiary Basin. We have examined the beds forming the outcrop of the Tertiary strata to the south-west at Woodcock Hill near Rickmansworth, and at Watford Heath and Bushey near Watford; and to the north-east at Hatfield and at Hertford. All along this line of outcrop we have had the Chalk on the north-west of us and the London Clay on the south-east, while immediately beneath our feet have been the sands, mottled clays, and pebble-beds of the Woolwich and Reading Series, reposing on the Chalk and overlaid by the London Clay, the only portion of which we could in some places see being its basement-bed.

Underlying the Woolwich and Reading beds, on the opposite side of our Chalk basin, south of London, are the Thanet Sands, but on this edge of the basin they are absent, the Reading beds here reposing immediately on the Chalk, which appears to have suffered some amount of denudation before their deposition. They are very different in character to their representatives south of London. In the neighbourhood of Woolwich especially, clays in thin layers predominate throughout, and fossils are frequent, and show that the beds are of fluviatile or estuarine origin; here there is usually but one thick bed of mottled clay, with sands above and below, and quite at the base a bed of rolled flint-pebbles in sand, apparently a true shingle-bed. Fossils are seldom found, and the general character of the beds indicates a marine origin, part at least being a littoral deposit.

It is this shore-deposit that we have now before us, for the Hertfordshire conglomerate is merely the lowest bed of the Woolwich and Reading Series—the shingle-bed of flint-pebbles consolidated

* See 'Trans. Herts Nat. Hist. Soc.,' Vol. I, p. xxxiii.

by the infiltration of silica. At Watford this shingle-bed is 15 feet thick, the black, rolled flint-pebbles being in a matrix of ochreous clayey sand, but not consolidated; and in fact it is only at this spot that the shingle-bed can now be seen *in situ* in the form of a conglomerate, or, as it is sometimes called, "plum-pudding stone." Blocks of this conglomerate occur, however, here and there, over a considerable portion of Hertfordshire, and they have also been seen in Essex. We know that the Reading beds once extended over the greater portion of Hertfordshire, by the outliers which are seen at various places, and it seems more probable that the blocks we meet with are relics of these beds of which the looser portions have been carried away by denudation, than that they have been transported in a northerly direction from the neighbourhood of Radlett. It is probable that the land over which flowed the rivers which deposited the clays, sands, and pebbles of the Woolwich and Reading Series was to the south of the London and Hampshire Tertiary Basin, where is now the English Channel, and on this supposition we should expect to see the beds to the north more marine in character than the more southerly portion of the series. From the very variable character of the whole of this series it may be inferred that in no locality where it occurs was it, or any portion of it, a deep-sea deposit. Littoral conditions may have prevailed over at least a considerable portion of Hertfordshire, so that there is no improbability in the shingle-bed having at one time been of considerable extent, and throughout this extent it may anywhere have been consolidated into a conglomerate.

We now, therefore, see before us a fragment of an old sea-shore which is usually seen as a bed of loose flint-pebbles in sand, sometimes clayey, the pebbles having been derived from the denudation of the Chalk. How is it then that it occurs here in the form of a conglomerate, not, as is most usual, with a matrix solidified by calcareous matter, but by siliceous? Professor Prestwich, in his well-known paper on "The Woolwich and Reading Series,"* says that in 1846 the mottled clays of the "Argile Plastique" of the Paris basin were found to contain "a very considerable proportion of gelatinous or soluble silica, *i.e.* silica in an active chemical state, and soluble in alkaline solutions without fusion." He then says that he has "recently tested the mottled clays from various places in the London district," and has found that "they also contain this gelatinous silica, which can be readily separated by boiling in a solution of caustic potash," the proportion being, however, very variable. As the stratum which immediately overlies our pebble-bed consists in this neighbourhood of mottled clays, it is probably the gelatinous silica from them which has converted the bed into a conglomerate, and which, in other places, where sands underlie these clays, has converted the sand here and there into a sandstone. As blocks of our conglomerate are found scattered far and wide, so are blocks of this sandstone, which are known as "sarsen-stones," "grey-wethers," and "Druid sandstones," and

* 'Quart. Journ. Geol. Soc.,' vol. x, p. 75.

it is quite as rare to find this sandstone in position as it is to find our Hertfordshire conglomerate.

The conglomerate is here seen to be split up into blocks, showing that it has been subjected to considerable disturbance, either by subsidence or upheaval, after its consolidation, and the hardness and durability of the siliceous cement is evidenced by the splitting of the pebbles in the general lines of fracture. In some places the pebbles have become so soft that they may be cut with a knife, while the matrix preserves its hardness. Another point of interest is that here and there the surface of the conglomerate is seen to be smooth and rounded, as if it had been subjected to the action of ice. It is the only rock we have anywhere in this neighbourhood, and probably the only rock in our Tertiary basin, which is sufficiently durable to show any trace of glacial action.

A careful examination of the conglomerate was then made in different parts of the pit, and pebbles here and there were freely subjected to the action of pen-knives, a few being found which could be cut into. The splitting up of the conglomerate was observed, and its surface was seen to be in some places evidently worn by attrition. The beautifully-white fine sand seen reposing upon an unconsolidated portion of the pebble-bed also attracted attention.

On leaving Newberries the road leading to Boreham Wood was taken for a short distance, and, turning off it towards Letchmoor Heath, a stream flowing out of Elstree Reservoir into the River Colne was crossed. The bed of this stream is frequently dry; it was so when crossed lower down on the way to Newberries four years ago, and there was not much water in it now, but the proximity of the underground reservoir, the plane of permanent saturation in the chalk, to which attention was soon to be directed, was evident from a stream of water running down the road, which was not merely surface-drainage from the recent rain, its source being beneath the surface.

The route was now past Kendall Hall and then past Kendall Pound, between which place and Battler's Green the principal "swallow-holes" in the district are to be seen, there being others near Letchmoor Heath and Bushey. On arriving at the Battler's Green swallow-holes no water was to be seen. There having been a long period of dry weather the recent rainfall would be speedily absorbed; but that sometimes a large quantity of water would be seen to disappear was evident from the amount of solid matter which had been carried away.

The following explanation of the occurrence of these swallow-holes was then given by the director.

The average yearly rainfall in this part of Hertfordshire for the last 20 or 25 years may, he said, be taken roughly as 26 inches. Of this amount scarcely a quarter, or 6½ inches, sinks through the soil, by far the greater portion being evaporated or absorbed by vegetation. The water which sinks through the soil ultimately finds its way to the rivers, usually appearing above the surface in

the form of springs. In this neighbourhood the springs will be found where the London Clay, or a clay bed of the Reading Series, crops out from under a bed of gravel. Sometimes, as in clayey districts, percolation is very slow, and the water soon collects on the surface into streamlets or brooks, but over the greater part of Hertfordshire percolation is comparatively rapid, the sub-soil being gravelly and the gravel reposing on chalk. The water, therefore, soon finding its way below ground, there are no small streams on the surface, and the rivers are dependent entirely on springs.

When water flowing over a bed of clay, whether as a streamlet on the surface of the land, or by percolation through gravel or sand underneath the surface, meets with a pervious bed such as the chalk cropping out from beneath the clay, it sinks into this pervious bed, usually almost imperceptibly, but occasionally, either from the stratum being exceptionally pervious, or from the body of water being unusually large, the water may be seen to disappear in what are called "swallow-holes." This phenomenon is frequently observed in chalk and limestone districts. When once the water has made for itself a channel in a calcareous rock, by a chemical action due to the water holding carbonic-acid gas in solution, the channel is gradually enlarged, and, although this action is going on generally throughout the rock, as seen by all water derived from limestone districts being "hard," that is, containing carbonate-of-lime, the more rapid action when a channel is formed frequently causes the surface of the land to sink, a considerable amount of matter being carried away either by chemical or mechanical action. In this way the Peak Cavern in Derbyshire has been formed, and the Mammoth Cave in Kentucky, and in these cases the course of the water can be traced from its disappearance from the surface to its appearance again above ground at the mouths of these caves. Here we see the water disappear, and we only know for certain that it reaches the plane of permanent saturation in the chalk and so finds its way to the rivers.

Some years ago the two Societies visited a picturesque pool near Watford, known as Otterspool. Looking into this pool of beautifully-clear water several distinct springs could be seen rising out of the chalk at the bottom, where the pool is about 16 feet deep. From these springs about 300,000 gallons of water a day now rise, and, flowing out of the pool in a powerful stream, augment the volume of the River Colne, and they have been known to yield a million gallons a day. The Rev. James C. Clutterbuck, in a paper on the "Geology and Water Supply of the Neighbourhood of Watford,"* says that it has been supposed that there is some connexion between the irruption of water at Letchmore Heath, referring to these swallow-holes, and the well-known copious issue of water at Otterspool. "There are," he adds, "stories of ducks having found their way thither by some subterranean passage; and measurements of the level at which the water stands thereabout, and in the direction of the pool, show a regularity not easily accounted for but by the

* 'Trans. Watford Nat. Hist. Soc.,' Vol. I, p. 125.

existence of some fault or fissure in that direction." Although we may discredit the "stories of ducks," the springs at Otterspool evidently arise from fissures or channels in the chalk extending in this direction, and it seems extremely probable that these and other swallow-holes in the parishes of Aldenham and Bushey contribute materially to the volume of water discharged by the springs.

When swallow-holes occur in the bed of a stream the water may sometimes be seen to disappear entirely in dry seasons, while when a large amount of water flows they may take part of it only and the stream may flow on merely diminished in volume. In the carrier which conveys the water from Elstree Reservoir to the River Brent there are some swallow-holes which have to be plugged when the water is discharged from the reservoir to prevent the waste of the greater part if not the entire volume of water. This carrier must be above the plane of permanent saturation of the Chalk, but most of our chalk-streams flow at the level of permanent saturation. This plane is not horizontal, the rivers flowing at the bottom of the valleys being at its lowest point, while on each side of the rivers the plane forms an incline towards the higher ground of from about 12 to 24 feet to the mile, varying in different years and at different times of the year. If in this valley the inclination of the surface of the ground did not exceed the inclination of the surface of the underground reservoir, the saturated chalk, the water would flow over the surface at the same time that it was flowing beneath the surface, but much more rapidly, for there is a resistance in the chalk, provided there is no channel or fissure, and it is this resistance, the amount of which is determined by the rapidity with which the chalk can absorb and part with water, which causes the plane of saturation to be inclined from the horizontal.

Water will always try to find its level, but, in the chalk, although always trying to do so, it scarcely ever suceeeds, there being, in wet weather at least, a constant accession from above. Thus by the accession of water by percolation from above, and the abstraction by springs, or wells, or by outlet into rivers below, an equilibrium in the plane of saturation is maintained which is represented in this neighbourhood by an angle of at least 12 feet to the mile.

After walking a short distance across the fields the party separated at Battler's Green, some walking to Radlett and others driving to Watford.

Field Meeting, 17th July, 1884.

WIDFORD.

The party assembled at Widford Station at about two o'clock, and proceeded first to Widford Church, which has recently been thoroughly restored. The paintings in the roof, executed with much skill and taste by Miss Gosselin, of Blakesware, were examined with great interest; and a fine old gateway in the wall of the churchyard, dating probably from the Tudor period, was also noticed. It was also found on examination that an old chamber

or vault with a brick-built and groined roof, adjoining the churchyard, and which was well known to one of the party in his earlier days, has almost entirely disappeared. A glimpse at the Rector's garden elicited an exclamation of surprise at the beauty of the view from it of the surrounding country, now at its best.

Continuing their walk through the village of Widford, the party proceeded to the opposite side of the valley in order to examine a large tumulus, or barrow. The mound is of considerable size, and is covered with a thick growth of underwood. Some of the party searched diligently for specimens of flint implements, but unfortunately without success. This barrow has never yet been opened.

Proceeding onwards, the walk was continued to Mardocks Station, whence Mr. Croft had very kindly arranged for his waggonette to convey the ladies to Fanhams Hall. The remainder of the party followed, and were most hospitably entertained by Mr. and Mrs. Croft, and a very pleasant hour was spent.

Several botanical specimens of interest were found, the following being a few of the rarer species in this neighbourhood:—*Epilobium angustifolium*, *Linaria spuria*, *Linaria minor*, *Parietaria officinalis*, *Reseda lutea*, and *Reseda luteola*.

Field Meeting, 1st November, 1884.

VERULAM WOODS AND GORHAMBURY PARK, ST. ALBANS.

The object of this, the third annual Cryptogamic Meeting of the Society, was to investigate the fungi, mosses, etc., of the woods in the neighbourhood of Gorhambury Park. The members assembled at the London and North-Western Station, St. Albans, at two o'clock, meeting here Dr. Braithwaite, F.L.S., Dr. M. C. Cooke, A.L.S., and Mr. Worthington G. Smith, F.L.S.

The Verulam Woods were first visited, and a number of mosses and fungi were found in the fosse which bounded the north-western side of the City of Verulam. On leaving these woods the Roman road known as Watling Street was traversed as far as its junction with the Hempstead Road, and a footpath across a field on the opposite side of this road was then taken. By the side of this footpath there is still standing a considerable block of the Roman wall of the municipium, on which grow several species of *Tortula*, and the "extinguisher moss," *Encalypta vulgaris*, but, owing to the very dry weather, this moss was not now to be seen. A number of the well-known "fairy-rings" next attracted attention, and a plentiful supply was obtained of the edible fungus, *Marasmius oreades*, which forms these rings by gradually spreading from a centre, and by its growth exhausting the soil of the nitrogenous matter necessary for its existence.

That part of the old city fosse known as "The Hollows" was then traversed, and this damp grassy glade yielded a rich harvest to the fungologists. On leaving it some fields were crossed and Gorhambury Park was entered. After spending some time in

investigating its cryptogamic flora, the park was left by the carriage-drive, and on the way back to St. Albans the members, numbering between twenty and thirty, were very kindly entertained at tea at Maynes Farm by Mrs. Purrott,

The following is a list of the fungi found during the walk, the species having been identified by Dr. M. C. Cooke, from whom the list has been received, and Mr. Worthington Smith. Of the 43 species enumerated, 15 have not been recorded in previous county lists. To these an asterisk is affixed.

HYMENOMYCETES.

Agaricus (*Lepiota*) *granulosus*, Fr.
,, (*Armillaria*) *melleus*, Vahl.
,, (*Tricholoma*) *nudus*, Fr.
,, ,, *personatus*, Fr.*
,, ,, *subpulverulentus*, Fr.*
,, (*Clitocybe*) *nebularis*, Fr.*
,, ,, *fragrans*, Fr.
,, ,, *cyathiformis*, Bull.
,, ,, *laccatus*, Fr.
,, ,, *radicatus*, Fr.*
,, ,, *longipes*, Bull.*
,, ,, *fusipes*, Bull.
,, ,, *dryophilus*, Fr.
,, (*Mycena*) *galericulatus*, Fr.
,, ,, *alcalinus*, Fr.
,, ,, *tenuis*, Bolt.*
,, (*Pholiota*) *marginatus*, Fr.*
,, (*Tubaria*) *furfuraceus*, Fr.*
,, (*Psalliota*) *campestris*, Fr.
,, (*Stropharia*) *æruginosus*, Curt.
,, ,, *squamosus*, Fr.
,, ,, *semiglobatus*, Fr.
Agaricus (*Hypholoma*) *fasciculare*, Fr.
,, ,, *hydrophilus*, Bull.*
,, (*Philocybe*) *semilanceatus*, Fr.
Coprinus niveus, Fr.
,, *plicatilis*, Fr.*
Hygrophorus virgineus, Fr.
,, *coccineus*, Fr.
Lactarius subdulcis, Fr.
Russula alutacea, Fr.*
Marasmius orcades, Fr.*
Polyporus versicolor, Fr.
,, *adustus*, Fr.*
,, *annosus*, Fr.
Stereum hirsutum, Fr.
Corticium læve, Fr.

GASTROMYCETES.

Scleroderma vulgare, Fr. *
Lycoperdon gemmatum, Fr.
,, *pyriforme*, Fr.

ASCOMYCETES.

Xylaria hypoxylon, Fr.
Rhytisma acerinum, Fr. *
Dothidea Ulmi, Fr.

The following mosses were found and identified by Dr. Braithwaite. Of the 32 species recorded, two, *Pottia Starkeana* and *Tortula vinealis*, are new to Hertfordshire.

ACROCARPI.

Weissia cirrhata, Hedw.
Dicranella heteromalla, Hedw.
Pottia Starkeana, Hedw.
Tortula vinealis, Brid.
,, *revoluta*, Schwg.
,, *lævipila*, Brid.
,, *ruralis*, L.
Grimmia apocarpa, L.
Orthotrichum affine, Schrad.
Mnium undulatum, Hedw.
Polytrichum commune, L.

PLEUROCARPI.

Fissidens taxifolius, L.
Leucodon sciuroides, L.
Homalia trichomanoides, Schreb.
Anomodon viticulosus, L.
Thuidium tamariscinum, Hedw.
Thamnium alopecurum, L.
Homalothecium sericeum, L.
Brachythecium glareosum, B. and S.
,, *velutinum*, L.
,, *rutabulum*, L.
Eurhynchium piliferum, Schreb.
,, *prælongum*, Dill.
Rhynchostegium confertum, Dicks.
Amblystegium serpens, L.
Hypnum cupressiforme, L.
,, *cuspidatum*, L.
,, *purum*, L.
Hylocomium squarrosum, L.
,, *triquetrum*, L.

Dr. Braithwaite also records the following Hepaticæ :—*Radula complanata*, L., and *Cephalozia bicuspidata*, L.

The meeting was under the direction of Mr. A. E. Gibbs.

ORDINARY MEETING, 18TH NOVEMBER, 1884, AT WATFORD.

JOHN EVANS, Esq., D.C.L., LL.D., Treas. R.S., F.S.A., F.L.S., F.G.S., Vice-President, in the Chair.

Miss Edwards, Westminster Lodge, St. Albans, and Mrs. Robins, The Elms, Watford, were proposed as Members of the Society.

The following lecture was delivered :—

"Our Serpent-foes in India." By Sir Joseph Fayrer, M.D., K.C.S.I., LL.D., F.R.S., F.Z.S., F.R.G.S. (Communicated by Arthur Stradling, C.M.Z.S.)

ORDINARY MEETING, 20TH NOVEMBER, 1884, AT HERTFORD.

R. T. ANDREWS, Esq., in the Chair.

The Rev. John Lingen Seager, M.A., High Street, Stevenage, was proposed as a Member of the Society.

The meeting was held in conjunction with the Hertfordshire Bee-Keepers' Association, and was devoted to a discussion on the recent advances in the art of Bee-keeping.

ORDINARY MEETING, 11TH DECEMBER, 1884, AT HITCHIN.

WILLIAM RANSOM, Esq., F.L.S., Vice-President, in the Chair.

The following paper was read :—

"On Spiders." By F. M. Campbell, F.L.S., F.Z.S., F.R.M.S.

The meeting was held in conjunction with the Hitchin Natural History Club.

ORDINARY MEETING, 16TH DECEMBER, 1884, AT WATFORD.

GEORGE ROOPER, Esq., F.Z.S., Vice-President, in the Chair.

Miss Edwards, Westminster Lodge, St. Albans; Mrs. Robins, The Elms, Watford; and the Rev. J. Lingen Seager, M.A., High Street, Stevenage, were elected Members of the Society.

Mrs. Applebee, Stanton House, St. Andrews, Watford; Mr. A. P. Blathwayt, Frogmore House, Watford; Mr. Thomas Alfred Dennison, Airedale House, Queen's Road, Watford; Sir James Longden, G.C.M.G., F.R.G.S., Longhope, St. Andrews, Watford; and Mr. Charles Edward Playfair, Staff-Surgeon R.N. retired, The Fishery, Boxmoor, were proposed as Members.

The following paper was read :—

"The Acclimatization of Food Fishes." By W. Oldham Chambers, F.L.S., Secretary of the National Fish-culture Association. (Communicated by F. G. Lloyd, Hon. Sec.)

Mr. Chambers said that the Acclimatization of Fishes was the science or art of distributing them from one country to another and retaining life amongst them in rivers, lakes, and other waters in which the fish did not previously exist. In

order to accomplish this with any degree of success, the first consideration should be to select waters resembling as nearly as possible those from which the fish were taken, and to provide them with food almost identical with that of their natural waters. On their induction, great care should be exercised in the observance of the minutest detail of diet. Full-grown fish should always be avoided on account of their incapacity to withstand the evils occasioned by their removal; only yearlings should be selected, as they possess greater immunity from the risk of transit. It was far better, however, to transport the ova when practicable, which had been done with great success abroad, as in the introduction of salmon into Australia, carp into America, and trout into numerous rivers and lakes throughout Europe. But before introducing foreign fishes into the waters of this country, we should first endeavour to improve the condition of our own national fishes. We should then make a most careful selection of species not detrimental to those which are indigenous.

Of salmon suitable for food-supply Mr. Chambers recommended the Rhine salmon, the Californian salmon, and the land-locked salmon recently discovered, which would prove invaluable in some of our rivers, lochs, and lakes. Of trout he had successfully introduced *Salmo levenensis* in large numbers into English waters. It had been proved conclusively that this species became acclimatized in lakes and rivers where currents are not strong, thus obviating difficulties which had arisen hitherto in selecting suitable waters for trout in Hertfordshire. *Salmo fontinalis* (the brook trout of America) might be cultivated in enclosed waters, and *S. ferox* (the great lake trout of Switzerland) could be easily raised, as the eggs could be imported in large quantities. Another fish of considerable economic value for acclimatization was *Cyprinus carpio*. Its culture in Europe dated back to the eleventh century, when it was introduced from Central Asia. It was described in the celebrated 'Boke of St. Albans' (1496) as a "deyntous fisshe."

Referring then to the culture of fish, Mr. Chambers said that we had in Great Britain vast areas of water lying waste which would produce an inexhaustible food-supply if utilised, under scientific manipulation, for fish-breeding purposes; we had also many thousands of acres of land partially covered with water, and valueless for agricultural purposes, and of land lying fallow through neglect and want of capital, which might be made profitable, if our English and Irish farmers could be taught that land might be alternated for aquacultural and agricultural uses; and he instanced his successful introduction for such culture of mirror-carp from Westphalia.

With regard to our national coarse fish, he could hardly conceive anything more beneficial than the introduction of our Norfolk strains of roach, perch, pike, tench, etc., into some of the depleted rivers of our large cities and manufacturing towns. Again, a vast and profitable field was open to the national economist by stocking the canals which intersect our inland counties.

In conclusion, Mr. Chambers recommended the appointment by the Crown of a Fish Commission, which he thought might develope a new industry, and create a cheap supply of food.

Mr. Rooper gave an account of the introduction of salmon into Van Diemen's Land (Tasmania), which was successfully accomplished by the carrying-out of a suggestion of his own. Twenty-five or thirty years ago he was a co-director with Mr. Ewell of the Van Diemen's Land Company, and he was also officially connected with his old friend the late Frank Buckland. Ewell and Buckland had failed in their attempts to convey the ova into Australia, having packed them in moss and other substances to keep them damp, with the result that the ova vivified in the tropics, and the young fish died. He was then owner of a fishery on the Tweed, and he had observed that in the winter many of the salmon-beds were entirely bare; the water would sink and the gravel-bed would freeze; but when the water came again and the banks thawed, the ova all came out quite fresh. He wrote to Mr. Ewell suggesting that if they froze the ova, conveying them to Australia in blocks of ice, which on arrival they put into a running stream, they might be successful, and a modification of the scheme which he explained in detail was successfully carried out. With reference to *Salmo ferox*, which he understood Mr. Chambers wished to introduce, a greater brute did not

live. He was a bad sporting fish, did not rise to the fly, was an ugly creature with great blotches, and was not worth catching.

Mr. F. G. Lloyd mentioned that he had had some experience of the usefulness of the carp in Germany, particularly in Saxony. It was brought to market by women, and farmers who lived at a distance bought a supply which they kept in receptacles in their streams and ditches, from time to time drawing upon them for their dinners. With regard to canals, in Hertfordshire long stretches of the Grand Junction Canal were stocked with fish either by private persons or societies, but they gave no adequate return. The bargemen had a triangular net which they put down as the boat went along, and they brought it up full of fish. So long as such a practice was allowed, it would be useless to stock canals with fish.

Mr. Littleboy asked whether in speaking of aquaculture as possible for farmers, Mr. Chambers meant that they should utilise the existing rivers or brooks, or form artificial reservoirs for pisciculture. Our Hertfordshire streams were scarcely pure enough now to admit of fish living in them. The fish that lived fifteen or twenty years ago in the little stream (the Gade) which flowed through his grounds could not live in it now, and he thought that no amount of fish-culture would pay for shutting up those great industries of the neighbourhood, the carrying-on of which polluted our rivers.

Mr. Chambers, in reply, said that to the present day ova were conveyed across the seas in a corner of the ice-room or refrigerating chamber. The waters into which he would introduce *Salmo ferox* would be those in which there was a large amount of bottom-fishing, for though *ferox* would not rise to a fly, he would take a worm. In waters where the indigenous fish were roach, perch, and tench, a non-migratory trout would be appreciated by the angler, though not equal to the migratory fish as an article of food. With regard to the destruction of fish by bargemen, if the canals were well stocked with fish, and were placed under a Preservation Society, the law of the land would stop the netting. As to aqua-culture, the idea he wished to convey was that throughout the country there were many waste pieces of land, partially covered with water, and growing only reeds and rushes, which were utterly valueless at present, but which might be made to produce a large quantity of fish. He had utilised many such pieces of land, making them into ponds in which he had grown very fine fish. In this county the porous nature of the strata would not allow of such treatment of waste land.

Mr. J. E. Littleboy then read the following note on "Grayling in the Colne and Gade."

An attempt to introduce grayling into the Colne, which appears to have been partially successful, has recently been made by Mr. A. H. Hibbert, of Munden Park. Mr. Hibbert writes, on the 1st of September, 1883:—"The grayling were sent to me as spawn two years ago and hatched out well. I estimate their number at over a thousand. When about a month old I turned them into a little gravelly ditch which flows into the river; on the 3rd of August I dragged and caught four—three of them close to the little ditch, the other some distance down the river. They weighed from four to five ounces each, measured about seven inches in length, and seemed to be in a particularly healthy and bright condition. I turned them in as an experiment, but I expect that there are a good many of them left; our net has a fair-sized mesh, and the grayling being a quick-moving fish, probably escaped us in numbers."

A similar experiment has been made by Lord Essex, who kas kindly supplied the following particulars:—"Some small fry were sent to me from the Dove, a stream in Derbyshire famous for grayling; I put them into the Gade, at Cassio Bridge, in May or June, 1882. Some months afterwards, when we dragged the river, a few were seen entangled in the weeds. I am told that in twelve months they will grow to three or four inches in length."

Dr. Hood, who is very familiar with the habits of the grayling, does not believe that it will be possible permanently to naturalize this fish in the waters either of the Colne or Gade. The experiments now reported will go far to test the accuracy of this opinion.

Ordinary Meeting, 6th January, 1885, at Watford.

George Rooper, Esq., F.Z.S., Vice-President, in the Chair.

Mrs. Applebee, Stanton House, Watford; Mr. A. P. Blathwayt, Frogmore House, Watford; Mr. T. A. Dennison, Airedale House, Watford; Sir James Longden, G.C.M.G., F.R.G.S., Longhope, Watford; and Mr. C. E. Playfair, The Fishery, Boxmoor, were elected Members of the Society.

Mr. H. Cayley, Brigade-Surgeon, Elm Grove, Watford, was proposed as a Member.

The following lecture was delivered:—

"The Nests and Eggs of Birds." By Henry Seebohm, F.L.S. F.Z.S. (*Transactions*, Vol. III, p. 255.)

Ordinary Meeting, 20th January, 1885, at Watford.

Alfred T. Brett, Esq., M.D., Vice-President, in the Chair.

Mr. H. Cayley, Elm Grove, Watford, was elected a Member of the Society.

Mr. Thomas John Broad, Queen Street, Watford; Mrs. Manning, North End House, Watford; Mr. T. J. Peacock, Queen Street, Watford; Mr. John William Robins, The Elms, Watford; and Mr. J. Ellis Stuart, Clay Hill, Bushey, Watford, were proposed as Members.

The following lecture was delivered:—

"The Origin and Constitution of Chalk and Flint, with special reference to their Foraminifera and other Minute Organisms." By Professor T. Rupert Jones, F.R.S., F.G.S. (*Transactions*, Vol. III, p. 143.)

Mr. A. P. Blathwayt and Mr. H. S. Sherry were elected Auditors of the accounts for 1884.

Ordinary Meeting, 3rd February, 1885, at Watford.

George Rooper, Esq., F.Z.S., Vice-President, in the Chair.

Mr. T. J. Broad, Queen Street, Watford; Mrs. Manning, North End House, Watford; Mr. T. J. Peacock, Queen Street, Watford; Mr. J. W. Robins, The Elms, Watford; and Mr. J. Ellis Stuart, Clay Hill, Bushey, were elected Members of the Society.

Mr. William Barker, Overbury, Watford, and Mr. Walter Edward Moore, Westfield, Watford, were proposed as Members.

The following lecture was delivered:—

"Indian Snakes and Snake-charming." By Sir Joseph Fayrer, M.D., K.C.S.I., LL.D., F.R.S., F.Z.S., F.R.G.S. (Communicated by Arthur Stradling, C.M.Z.S.)

Anniversary Meeting, 17th February, 1885.

(At Watford.)

The Right Honourable the Earl Cowper, K.G., President, in the Chair.

Sir Richard Owen, K.C.B., M D., D.C.L., LL.D. F.R.S., F.L.S., F.G.S., etc., Sheen Lodge, Richmond Park, East Sheen; and Henry Seebohm, F.L.S., F.Z.S., 22, Courtfield Gardens, Cromwell Road, London, S.W., were elected Honorary Members of the Society.

The Report of the Council for 1884, and the Treasurer's Account of Income and Expenditure, were read and adopted.

The President delivered an Address. (*Transactions*, Vol. III, p. 157.)

The following gentlemen were duly elected as the Officers and Council for the ensuing year :—

President.—Professor John Attfield, Ph.D., F.R.S., F.C.S.

Vice-Presidents.—Alfred T. Brett, M.D.; The Right Honourable the Earl Cowper, K.G.; John Hopkinson, F.L.S., F.G.S., F.R.M.S., F.R.Met.Soc.; William Ransom, F.L.S.; George Rooper, F.Z.S.; C. E. Shelly, B.A., M.B.

Treasurer.—Charles R. Humbert.

Honorary Secretaries.—Richard B. Croft, R.N., F.L.S., F.R.M.S.; and Frederick George Lloyd.

Librarian.—Allen Barraud.

Curator.—William Verini.

Other Members.—F. Haycraft Berry, M.B.; Alfred Fowell Buxton; F. Maule Campbell, F.L.S., F.Z.S., F.R.M.S.; E. M. Chater; John Evans, D.C.L., LL.D., F.R.S., F.S.A., F.L.S., F.G.S., etc.; Arthur E. Gibbs; T. Mark Hovell, F.R.C.S.; John E. Littleboy; F. W. Phillips, F.L.S.; Frank W. Silvester, F.R.Met.Soc.; Arthur Stradling, C.M.Z.S.; John Weall.

It was then resolved—

That the thanks of the Society be given to the Right Honourable the Earl Cowper, K.G., retiring from the office of President; to Mr. Alfred Fowell Buxton and Mr. John Evans, D.C.L., LL.D., F.R.S., F.S.A., F.L.S., F.G.S., etc., retiring from the office of Vice-President; and to the Rev. Canon Bradby, D.D., Mr. Alfred J. Copeland, and the Rev. Edward T. Vaughan, M.A., retiring from the Council.

Report of the Council for 1884.

In presenting the tenth Annual Report, the Council of the Hertfordshire Natural History Society and Field Club can again congratulate the members upon the work done in the investigation of the Natural History of the County, and in the dissemination of information on Natural History, as also on the number of valuable papers and lectures which have been read or delivered at the evening meetings.

During the year, seventeen ordinary members have been elected, twenty-four members have resigned, and the Council regrets to have to record the loss of two members by death, Mr. William A. Tooke, M.A., and Dr. J. Gwyn Jeffreys, F.R.S.

To Dr. Gwyn Jeffreys the Society owes a deep debt of gratitude. He was one of the original members of the Society, and one of the first vice-presidents in 1875, a member of the council from 1876 until 1879, when he was elected President, from which office he retired by rotation in 1881, and became Vice-President until 1883, then being made an honorary member. During the two years of his presidency there were but few meetings in either division of the county from which he was absent.

The census of the Society at the end of the years 1883 and 1884 was as follows :—

	1883.	1884.
Honorary Members	19	18
Life Members	42	42
Annual Subscribers	219	211
	280	271

The second volume of the Society's 'Transactions' under its altered title (the fourth of the entire series) has been completed, and the third volume has been commenced, two parts of the former, and three of the latter (containing together 204 pages and 6 plates) having been published during the year.

For the illustrations which have appeared in the second volume, the Society is indebted as usual to the liberality of authors, Mr. F. W. Phillips having supplied the plate illustrating *Chlorodesmos hispida*, a new flagellate animalcule from the neighbourhood of Hertford; Mr. J. Vincent Elsden the two maps of Hertfordshire, showing its superficial geology and agricultural features; and Mr. R. B. Croft the woodcut of a tulip-tree formerly growing at Waltham Abbey.

The following papers and lectures have been read or delivered during the year 1884 :—

Jan. 10, at St. Albans.—The Recorded Occurrences of Land and Fresh-water Mollusca in Hertfordshire; by W. Denison Roebuck, F.L.S., and John W. Taylor.

—— Remarks on the Land Mollusca, with reference to their investigation in Hertfordshire; by John Hopkinson, F.L.S., F.G.S.

—— List of Land and Fresh-water Mollusca observed in Hertfordshire; by Ada Selby; J. Gwyn Jeffreys, LL.D., F.R.S., F.L.S., F.G.S.; W. S. A. Griffith, F.R.C.S.; and Alfred T. Brett, M.D. Compiled by John Hopkinson, F.L.S.

—— 15, at Watford.—Notes on Boulders and Boulder-clay in North Hertfordshire; by H. George Fordham, F.G.S.

—— On the Microscopic Structure of Boulders found in the North of Hertfordshire; by J. Vincent Elsden, B.Sc., F.C.S.

—— 24, at Hertford.—On Dene Holes and Artificial Caves with Vertical Entrances; by F. C. J. Spurrell, F.G.S.

Feb. 19, at Watford.—Anniversary Address; by John Evans, D.C.L., LL.D., F.R.S., F.S.A., F.L.S., F.G.S., Vice-President.

—— 28, at Hertford.—Notes on the Protozoa of Hertfordshire, Section Discostomata; by F. W. Phillips, F.L.S.

March 18, at Watford.—Notes on the Musci, with an outline of a Hertfordshire Moss-Flora; by Arthur E. Gibbs.
—— Notes on Lepidoptera observed in the neighbourhood of Sandridge, Herts; by A. F. Griffith, M.A.
—— Notes on Birds observed in Hertfordshire during the year 1883; by John E. Littleboy.
April 15, at Watford.—List of Flowering Plants observed in Hertfordshire during the year 1883; by Ada Selby.
—— Report on Insects observed in Hertfordshire during the year 1883; by F. W. Silvester, F.R.Met.Soc.
—— Notes on some Scolecida; by Alfred T. Brett, M.D.
—— On the Poisonous Effects of the Common Yew; by Alfred T. Brett, M.D.
—— 24, at Hertford.—Meteorological Observations taken at Throcking, Buntingford, during the year 1883; by the Rev. C. W. Harvey, M.A., F.R.Met.Soc.
—— Report on the Rainfall in Hertfordshire in 1883; by the Rev. C. W. Harvey, M.A., F.R.Met.Soc.
—— On Instinct; by F. Maule Campbell, F.L.S., F.Z.S., F.R.M.S.
Nov. 18, at Watford.—Our Serpent-foes in India; by Sir Joseph Fayrer, M.D., K.C.S.I., LL.D., F.R.S., etc.
Dec. 11, at Hitchin.—On Spiders; by F. Maule Campbell, F.L.S., F.Z.S., F.R.M.S.
—— 16, at Watford.—The Acclimatization of Food Fishes; by W. Oldham Chambers, F.L.S.

The Society is greatly indebted to your Vice-President, Dr. John Evans, F.R.S., for his kindness in taking the chair and delivering an address at the Anniversary Meeting, in the unavoidable absence of your President, Earl Cowper, K.G.

The following Field Meetings were held during the year 1884:—

April 19.—Park Street and Frogmore.
May 31.—Rickmansworth Common Moor and Moor Park.
June 7.—Aldbury Owers, Tring.
—— 21.—Leavesden Woods, Watford.
July 12.—Radlett and Battler's Green.
—— 17.—Widford.
Nov. 1.—Verulam Woods and Gorhambury Park, St. Albans.

The meeting on the 12th of July was held in conjunction with the Geologists' Association. The meeting on the 1st of November was the third annual Cryptogamic Meeting, and on this occasion the members had the advantage of the presence of Dr. Braithwaite, F.L.S., Dr. M. C. Cooke, A.L.S., and Mr. Worthington G. Smith, F.L.S.

For hospitality kindly afforded at the Field Meetings the Society is indebted to Mr. Rooper at the Watford, Mr. Croft at the Widford, and Mr. Purrott at the St. Albans meeting.

In addition to the Field Meetings, a visit was paid on the 3rd of May to the Natural History Department of the British Museum, South Kensington, where the members had the advantage of the most interesting and instructive remarks of Dr. Günther, F.R.S., on the Mammalia, and Mr. R. Bowdler Sharpe on the birds, to both of whom a hearty vote of thanks was accorded by the members present.

On Wednesday, the 8th of October, a conversazione was given at the Public Library, by the Chairman, Mr. Weall, at which a room

was appropriated to exhibits by members of the Society. There was a good collection of microscopes, and an interesting display of natural objects, including a number of living reptiles exhibited by Mr. Stradling, amongst them being five pythons from Zululand, a sun-devil from Ashantee, and a Paranese tree-snake from Brazil.

The new library catalogue announced in the last report as then being in preparation, is now in the press; the catalogue itself being already in type. The Council having decided that a subject-index should be added to it, this is now being prepared by your Editor, and as soon as it is completed, the catalogue will be issued. The number of volumes now in the Society's library is about 1000, of which nearly half are botanical works.

The Council regrets that your Editor has decided to abandon the editorship of the late Mr. R. A. Pryor's 'Flora of Hertfordshire.' He has devoted a considerable amount of time and labour upon it, in preparing a portion of it for the press, and in the subsequent revision of this portion, comprising the orders Ranunculaceæ, Berberidaceæ, Nymphæaceæ, Fumariaceæ, and Cruciferæ. The first sheet of sixteen pages is complete, carrying the work to the end of Nymphæaceæ, but, judging from the labour involved in achieving this inconsiderable result, your Editor considers that the limited time at his disposal will be better bestowed upon other work for the Society. The thanks of the Society are due to Mrs. Pryor for the donation of £20 towards the cost of editing her son's work. Of this a small amount has been expended in the purchase of a few necessary books and the ordnance maps of the county. The Council will endeavour to secure the services of a botanist competent to carry on the work, and who will bring it out in a manner which will do credit to its author, who had an almost unequalled critical knowledge of British plants, combined with a most extensive acquaintance with botanical literature, British and foreign, from before the time of Linnæus to the present day.

The Society's library is in a satisfactory condition. There have been several donations of books during the past year, in addition to about fifty numbers of Transactions and Proceedings, received in exchange from other societies. A new book-case is being made which will greatly facilitate the arrangement of the books.

The financial position of the Society is as satisfactory as in former years. The balance in hand is about the same as at the end of the year 1883, but during the present year it will probably be reduced, owing to the expenditure which the catalogue of the library and the new book-case will necessitate.

In conclusion the Council has to express the thanks of the Society to the Committee of the Watford Public Library for the accommodation afforded for your library and the Watford meetings, and also to the members of the Hertford Literary and Scientific Institution for the continued free use of their rooms for the Hertford meetings.

INCOME AND EXPENDITURE FOR THE YEAR ENDING 31st DECEMBER, 1884.

Dr.	£	s.	d.
To Balance brought forward	55	14	6
,, Subscriptions for 1883	4	0	0
,, ,, ,, 1884	91	10	0
,, ,, ,, 1885	25	10	0
,, ,, ,, 1886	1	10	0
,, Entrance Fees	6	10	0
,, Dividend on £203 4*s.* 6*d.* Consols (less Income Tax)	5	18	10
,, Interest on £100 on deposit at London & County Bank	1	17	10
,, Sale of 'Transactions'	1	5	7
,, Donation from Mrs. Pryor	20	0	0
	£213	16	9

Cr.	£	s.	d.
By Stationery	1	3	6
,, Printing 'Transactions'	79	7	6
,, Miscellaneous Printing	12	3	9
,, Expenses of Meetings	9	11	6
,, Library	15	0	0
,, Salary of Assistant	6	0	0
,, Postages	24	8	8
,, Sundry small Expenses	1	8	9
,, Expenses *re* Bequest of the late Mr. R. A. Pryor	3	10	0
,, Balance at Bank	61	3	1
	£213	16	9

Amount invested in the purchase of £203 4*s.* 6*d.* Consols .... £198 15*s.*
,, on deposit at the London and County Bank .... 100 0*s.*

Audited and found correct, this 16th day of February, 1885, { HENRY S. SHERRY. ARTHUR P. BLATHWAYT.

Donations to the Library in 1884.

Title.	Donor.
Bonney, Prof. T. G. On the Microscopical Structure of a Boulder from the Cambridge Greensand. (*Proc. Cambridge Philos. Soc.*, 1884.)	*Mr. H. G. Fordham.*
Cooke, M. C. (Ed.) Grevillea. Vol. xii, Nos. 64-66. 8vo. London	*The Editor.*
Crosskey, Rev. H. W. Report of the Erratic Block Committee of the British Association for 1883	*Mr. H. G. Fordham.*
Elsden, J. V., and Lowe, W. B. Lecture-notes on Physical Geography and Geology. 8vo. Rugby, 1884.	*Mr. J. V. Elsden.*
Evans, Dr. John. Anniversary Address to the Royal Society, 1884. 8vo. London, 1884	*The Author.*
Ewing, Rev. J. W. Some Materials for a Flora of Wrotham and its Neighbourhood. 8vo. West Malling, 1883	*The Author.*
Glasscock, J. L., jun. The Records of St. Michael's Parish Church, Bishop's Stortford. 8vo. London, 1882	*The Author.*
Holmes, T. V. Notes on Coal Measures, Mammalian Remains, etc., and Water Supply in the Carlisle Basin. (*Trans. Cumb. Assoc.*, 1884.)	*The Author.*
Hulke, J. W. Address delivered at the Anniversary Meeting of the Geological Society of London, February, 1883. 8vo. London, 1883	*The Author.*
Method, E. V. Notes on Stevenage and Baldock. 8vo. St. Albans, 1884	*The Publishers.*
Ormerod, Eleanor A. Guide to the Methods of Insect Life. 8vo. London, 1884	*The Authoress.*
——. Report of Observations of Injurious Insects for 1883. 8vo. London, 1884.	,,
Somerville, Mary. Physical Geography. 2 vols. 8vo. London, 1848.	*Mr. J. Hopkinson.*
Symons, G. J. (Ed.) Monthly Meteorological Magazine. Vol. xix. 8vo. London, 1884	*The Editor.*
——. British Rainfall, 1883. *Ib.*	,,
Whitaker, W. On the Area of Chalk as a Source of Water Supply. 8vo. London, 1884	*The Author.*

Received in Exchange, 1884.

American Museum of Natural History. Annual Report, 1883. 8vo. New York, 1884.

Bath Natural History and Antiquarian Field Club. Proceedings. Vol. v, part 3. 8vo. Bath, 1884.

Belfast Naturalists' Field Club. Proceedings. Ser. II, Vol. ii, part 3. 8vo. Belfast, 1884.

————. Annual Reports for 1882-83 and 1883-84. *Ib.*

Boston Society of Natural History. Proceedings. Vol. xxi, part 4, and Vol. xxii, part 1. 8vo. Boston, 1883.

Brighton and Sussex Natural History Society. Annual Reports for 1883 and 1884. 8vo. Brighton, 1884.

Bristol Naturalists' Society. Proceedings. New Series, Vol. iv, part 2. 8vo. Bristol, 1884.

Cardiff Naturalists' Society. Report and Transactions for 1883. 8vo. Cardiff, 1884.

Chester Society of Natural Science. Annual Report for 1883-84. 8vo. Chester, 1884.

Conchology, Journal of. Vol. iv, Nos. 5-8. 8vo. Leeds, 1884.
Croydon Microscopical and Natural History Field Club. Proceedings and Transactions for 1883-84. 8vo. Croydon, 1884.
Edinburgh Botanical Society. Transactions. Vol. xv, part 1. 8vo. Edinburgh, 1883.
Edinburgh, Royal Physical Society of. Proceedings, Session 1882-83. 8vo. Edinburgh, 1883.
Essex Field Club. Transactions. Vol. iii, part 8. 8vo. Buckhurst Hill, 1883.
———. Report for 1883. *Ib.* 1884.
Geological Society. Abstracts of the Proceedings for 1882-83 and 1883-84. 8vo. London, 1883-84.
Geologists' Association. Proceedings. Vol. viii, Nos. 4 to 7. 8vo. London, 1884.
Glasgow, Philosophical Society of. Proceedings. Vol. xv. 8vo. Glasgow, 1884.
Hemel Hempstead Natural History Society. Annual Report for 1883. 8vo. Hemel Hempstead, 1884.
Liverpool Geological Society. Proceedings. Vol. iv, part 6. 8vo. Liverpool, 1884.
Liverpool Naturalists' Field Club. Proceedings for 1883-84. 8vo. Liverpool, 1884.
Liverpool Literary and Philosophical Society. Proceedings, 1880-83. 8vo. Liverpool, 1881–84.
Manchester Field Naturalists' and Archæologists' Society. Report and Proceedings for 1883. 8vo. Manchester, 1884.
Manchester Geological Society. Transactions. Vol. xvii, Nos. 11-18. Vol. xviii, Nos. 1, 2. 8vo. Manchester, 1884.
Manchester Literary and Philosophical Society. Proceedings. Vols. xx-xxii. 8vo. Manchester, 1881–83.
———. Memoirs. Series III, Vol. vii. 8vo. London, 1883.
———. A Centenary of Science in Manchester. By R. Angus Smith. 8vo. London, 1883.
Manchester Scientific Students' Association. Report and Proceedings for 1879 and 1881-83. 8vo. Manchester, 1880-84.
Marlborough College Natural History Society. Report for 1883. 8vo. Marlborough, 1884.
Meteorological Society. Quarterly Journal. New Series, Vol. x. 8vo. London, 1884.
———. The Meteorological Record. Nos. 10-12. 8vo. London, 1884.
Microscopical News. Vol iv. 8vo. London, 1884.
Microscopical, Royal, Society. Journal. Series II, Vol. iv. 8vo. London, 1884.
Microscopy and Natural Science, Journal of. Vol. iii, Part 9. 8vo. London, 1884.
Midland Naturalist. Vol. vii. 8vo. London and Birmingham, 1884.
New York Academy of Sciences. Transactions. Vol. ii, Nos. 1-8. Annals. Vol. ii, Nos. 10, 11, 13. Vol. iii, Nos. 1, 2. 8vo. New York, 1883.
Norfolk and Norwich Naturalists' Society. Transactions. Vol. iii, parts 4 and 5. 8vo. Norwich, 1884.
Norwich Geological Society. Proceedings, 1878-80. 8vo. Norwich, 1880.
Northamptonshire Natural History Society and Field Club. Transactions. Vol. iii, Nos. 17-20. 8vo. Northampton, 1884.
Northern Microscopist. Vol. iv. 8vo. London, 1884.
Quekett Microscopical Club. Journal. New Series, Vol. i, Nos. 7-10. 8vo. London, 1884.
Rugby School Natural History Society. Report for 1883. 8vo. Rugby, 1884.
Science Gossip. Vol. xx. 8vo. London, 1884.
Science Monthly. Vol. i, Nos. 4–12. 8vo. London, 1884.
Scottish Naturalist. New Series. Vol. i, Nos. 3–6. 8vo. Edinburgh and London, 1884.

Smithsonian Institution. Annual Report for 1882. 8vo. Washington (U.S.A.), 1883.
Somersetshire Natural History and Archæological Society. Proceedings for 1883. 8vo. Taunton, 1884.
South London Microscopical and Natural History Field Club. Report for 1884. 8vo. London, 1884.
United States. Compendium of the Tenth Census. Parts 1, 2, 1880. 8vo. Washington (U.S.A.), 1883.
United States Entomological Commission. Third Report (1880-82). 8vo. Washington (U.S.A.), 1883.
United States Geological and Geographical Survey. Report for 1878. Parts 1 and 2. 8vo. Washington (U.S.A.), 1883.
————. Maps, Panoramas, and Tertiary History of the Grand Cañon District, with Atlas. *Ib.*
————. Second Annual Report. *Ib.*
Wiltshire Archæological and Natural History Society. Magazine. Vol. xxi, Nos. 62, 63. 8vo. Devizes, 1883.
Yorkshire Geological and Polytechnic Society. Proceedings. New Series, Vol. viii, part 2. 8vo. Leeds, 1884.
Yorkshire Naturalists' Union. Transactions. Part 7. 8vo. London and Leeds, 1884.

Ordinary Meeting, 19th February, 1885, at Hertford.

C. E. Shelly, Esq., B.A., M.B., Vice-President, in the Chair.

The following papers were read:—

1. "List of Works on the Geology of Hertfordshire, 1874-83." By John Hopkinson, F.L.S., F.G.S., etc. (*Transactions*, Vol. III, p. 165.)

2. "Some Hertfordshire Well-sections." By William Whitaker, B.A. (Lond.), F.G.S., Assoc.Inst.C.E. (*Transactions*, Vol. III, p. 173.)

Ordinary Meeting, 3rd March, 1885, at Watford.

Professor John Attfield, Ph.D., F.R.S., F.C.S., President, in the Chair.

Mr. William Barker, Overbury, Watford, and Mr. W. E. Moore, Westfield, Watford, were elected Members of the Society.

The Rev. H. F. H. Burchell-Herne, Bushey Grange, Watford; Mr. James Hadley, Warwick House, Watford; Professor T. McKenny Hughes, M.A., F.S.A., F.G.S., Trinity College, Cambridge; Mrs. Molyneux, Langley House, King's Langley; Miss Pemberton, Langley House, King's Langley; and Mr. W. F. D. Schreiber, Dalton House, Watford, were proposed as Members.

The following papers were read:—

1. "Diatoms: their Nature and Habits." By Francis Ransom. (*Transactions*, Vol. III, p. 197.)

2. "Notes on Birds observed in Hertfordshire during the year 1884." By John E. Littleboy. (*Transactions*, Vol. III, p. 207.)

Mr. Ransom's paper was illustrated by Mr. F. W. Phillips, F.L.S., by means of his refulgent diagrams.*

* Described in 'Trans. Herts Nat. Hist. Soc.,' Vol. II, p. xli.

Ordinary Meeting, 24th March, 1885, at Watford.

Professor John Attfield, Ph.D., F.R.S., F.C.S., President, in the Chair.

The Rev. H. F. H. Burchell-Herne, Bushey Grange, Watford; Mr. James Hadley, Warwick House, Watford; Professor T. McKenny Hughes, M.A., F.S.A., F.G.S., Trinity College, Cambridge; Mrs. Molyneux, Langley House, King's Langley; Miss Pemberton, Langley House, King's Langley; and Mr. W. F. D. Schreiber, Dalton House, Watford, were elected Members of the Society.

Mr. Daniel Hill, Herga, St. Andrews, Watford, and Mr. E. H. Hoddinott, 43, Upper Park Road, Haverstock Hill, London, N.W., were proposed as Members.

The following papers were read:—

1. "Meteorological Observations taken at Wansford House, Watford, during the year 1883." By John Hopkinson, F.L.S., F.G.S., F.R.Met.Soc. (*Transactions*, Vol. III, p. 181.)

2. "Meteorological Observations taken at Wansford House, Watford, during the year 1884. By John Hopkinson, F.L.S., etc. (*Transactions*, Vol. III, p. 219.)

The President asked what relation the average rainfall of the last nine years bore to that of a long period, and whether during the last few years a smaller quantity of water had not got down to the underground reservoir than formerly, owing to greater evaporation from the prevalence of wind and sunshine.

Mr. Littleboy said that the underground reservoir had overflowed more frequently the last nine years than he remembered it ever to have done before.

Mr. Hopkinson replied that the average rainfall at Watford for the last 25 or 30 years was probably about 26 inches, while that of the nine years 1875-83, as stated in his paper, was 32 inches. The year 1874 was a dry year, and 1884 was the only dry year since that. It had been remarked that years ending with "4" were usually dry, and an endeavour had also been made to connect the rainfall with the sun-spot period, about 11½ years; but he considered that any coincidences which could be traced were purely accidental; for if the fluctuations of the rainfall depended upon cosmical phenomena, the rainfall of the whole world should be taken into account, and not that of a single country or county. The amount of percolation depended upon the period of the year when the rain fell, rain falling in summer evaporating and being absorbed by vegetation to a much greater extent than rain falling in winter. The Hertfordshire Bourne had flowed about every alternate year lately, while once in five or six years seemed to have been more usual previously. It would therefore seem that there was, at least, no diminution in the supply of water to the underground reservoir. Increased drainage would affect this most, by carrying the water more rapidly off the land, and thus allowing a smaller quantity to percolate through the soil.

3. "Report on Phenological Phenomena observed in Hertfordshire during the year 1883." By John Hopkinson, F.L.S., etc. (*Transactions*, Vol. III, p. 191.)

4. "Report on Phenological Phenomena observed in Hertfordshire during the year 1884." By John Hopkinson, F.L.S., etc. (*Transactions*, Vol. III, p. 227.)

Mr. Littleboy observed that there was a remarkable similarity in the report of 1883 to the present season. The spring flowers came forward rapidly this year and were put back by unfavourable weather. There had been little progress the last fortnight.

5. "Notes on a Whirlwind at Ivinghoe, 11th September, 1834." By John E. Littleboy. (*Transactions*, Vol. III, p. 236.)

The President asked if any water was drawn up by the whirlwind, and if this was the only Hertfordshire whirlwind on record. He believed that physicists were quite at fault in explaining such phenomena, and hoped that accurate observations by such Societies as theirs would throw some light on their causes.

Mr. Hopkinson mentioned a whirlwind which occurred a few years ago about half way between Watford and St. Albans,* and related some of its remarkable effects. He thought it would be more correct to say that trees were drawn out of the ground than that they were blown down, for whirlwinds seemed to have more a power of suction than of direct pressure, in fact they appeared to be like waterspouts in their nature.

Mr. Littleboy said that the oak tree he mentioned had the appearance of having been twisted round and drawn out, with two or three tons of earth about its roots, leaving a round and conical hole in the ground.

6. "List of Flowering Plants observed in Hertfordshire during the year 1884." By Ada Selby.†

7. List of Lepidoptera observed in the neighbourhood of Hitchin and at Stevenage." By John Hartley Durrant, F.E.S. (Communicated by A. F. Griffith, M.A.) (*Transactions*, Vol. III, p. 261.)

8. "Note on a Curious Habit of the Wagtail." By J. Henry James. (*Transactions*, Vol. III, p. 237.)

The President remarked that it seemed most natural to infer that wagtails flew against a window in such a peculiar manner in search of food, but it might be that they sought warmth. It was well known that the air outside the window of a room in which there was a fire was warm, and as insects sought such warm layers of air, birds might also do so; or, again, they might be attracted by their own image.

Mr. Littleboy said that wagtails were known to have this peculiar habit of occasionally flying against windows. It might be that they did so to obtain insects, but he scarcely thought that such was the case. It was very rare for a pied wagtail to remain the whole of the winter in this district, and he thought it must have been a grey wagtail which Mr. James observed at this period.

Mr. Hopkinson said that it was not always the case that wagtails went from one window to another as there was a light or a fire in the room, for he knew of an instance at Kingsbury, St. Albans, where a wagtail flew against one window only in the house at intervals for some months. An ants' nest was afterwards found in the window-sill.

Field Meeting, 26th March, 1885.

ALDBURY AND ASHRIDGE PARK.

At the "Fungus Foray" at St. Albans last autumn a desire was expressed for an annual "Moss Hunt" early in spring. For the first of these the neighbourhood of Aldbury was chosen, in order to search the chalk slopes of Aldbury Owers and Moneybury Hill. It was a whole-day meeting, the party, fifteen in number, assembling at Tring Station at half-past eleven, under the guidance of Mr. Hopkinson, and with Dr. Braithwaite and Mr. E. M. Holmes as botanical referees.

The habitat of the pasque-flower (*Anemone Pulsatilla*) was first visited, and this very local plant was found to be just coming into

* See 'Trans. Herts Nat. Hist. Soc.,' Vol. II, p. 95.

† This list, recording ten species only, will be incorporated with the list for 1885.

flower. It is only known to occur elsewhere in Hertfordshire in a very few localities in the Ouse river-basin on the extreme north of the county.

From the hill above Tring Station the wood called Aldbury Owers was entered, and in and about here were found the mosses *Weissia microstoma*, *Encalypta streptocarpa*, *Fissidens calcareus*, *Hypnum molluscum*, and *H. polymorphum*, new to Hertfordshire. The Aldbury valley or coomb in the Chalk was then crossed and Moneybury Hill ascended. Here *Funaria fascicularis* and *Sclerodium illecebrum* were detected, and in a pond near the Column, *Pottia intermedia*. Luncheon was now partaken of, and the walk was then continued through Sallow Copse to Ringsall, and from there for a considerable distance through Ashridge Park, this part of the walk being in Buckinghamshire. On re-entering Hertfordshire, *Archidium alternifolium*, *Thuidium recognitum*, and *Cylindrothecium concinnum* were found in Ashridge Park; and, in the Avenue, on the wall dividing the park from Moneybury Common, *Barbula insulana*. Continuing along the Avenue, Aldbury was soon reached, and here *Barbula marginata* was seen on damp bricks forming the side of a drain, and *Bryum murale* on a new wall. After having tea in Aldbury, the party walked back to Tring Station.

The following is a complete list, contributed by Mr. Holmes, of the mosses collected by the members and identified by Dr. Braithwaite and himself, only the species new to the county since the publication by Mr. A. E. Gibbs of a "Preliminary Hertfordshire Moss-flora" having been enumerated above. To these an asterisk is affixed.

ACROCARPI.

Weissia microstoma, Hedw.*
,, *cirrhata*, Hedw.
Dicranum scoparium, L.
,, *palustre*, Bry. Brit.
Pleuridium subulatum, L.
,, *alternifolium*, B. and S.*
Pottia truncata, L.
,, *intermedia*, Turn.*
Didymodon rubellus, B. and S.
Ditrichum flexicaule, Schwg.
Barbula marginata, B. and S.*
,, *muralis*, L.
,, *fallax*, Hedw.
,, *insulana*, De Not.*
,, *revoluta*, Schwg.
,, *convoluta*, Hedw.
,, *ruralis*, L.
Ceratodon purpureus, L.
Encalypta streptocarpa, Hedw.*
Grimmia apocarpa, L.
,, *pulvinata*, Dill.
Orthotrichum diaphanum, Schrad.
,, *leiocarpum*, B. and S.
Funaria fascicularis, Dicks.*
Webera nutans, Schreb.
Bryum murale, Wils.*
,, *cæspiticium*, L.
Bryum argenteum, L.
,, *capillare*, L.
Mnium undulatum, Hedw.
,, *rostratum*, Schrad.
,, *hornum*, L.
Atrichum undulatum, L.
Polygonatum nanum, Neck.
Fissidens calcareus, Nutt.*
,, *taxifolius*, L.

PLEUROCARPI.

Leucodon sciuroides, L.
Neckera pumila, Hedw.
,, *complanata*, L.
Anomodon viticulosus, L.
Thuidium tamariscinum, Hedw.
,, *recognitum*, Hedw.*
Cylindrothecium concinnum, De Not.*
Isothecium myurum, Poll.
Homalothecium sericeum, L.
Camptothecium lutescens, Huds.
Sclerodium illecebrum, Schwg.
Brachythecium albicans, Neck.
,, *velutinum*, L.
,, *rutabulum*, L.
Eurhynchium striatum, Schreb.
,, *crassinervium*, Tayl.
,, *piliferum*, Schreb.
,, *Swartzii*, Turn.

Eurhynchium prælongum, Dill.
Rhynchostegium confertum, Dicks.
Amblystegium serpens, L.
Hypnum cupressiforme, L.
,, *resupinatum*, Wils.
,, *molluscum*, Hedw.*
,, *polymorphum*, Hedw.*
Hypnum chrysophyllum, Brid.
,, *cuspidatum*, L.
,, *Schreberi*, Ehrh.
,, *purum*, L.
Hylocomium splendens, Dill.
,, *squarrosum*, L.
,, *triquetrum*, L.

The following Hepaticæ (scale-mosses) were detected by Mr. Holmes:—*Porella platyphylla*, L., *Lophocolea heterophylla*, Schrad., and *Jungermannia turbinata*, Rad.

Field Meeting, 11th April, 1885.

RICKMANSWORTH, CHENEYS, AND FLAUNDEN.

Although Cheneys (or Chenies) is the prettiest place in the neighbourhood of Watford, it has not before the present occasion been visited by the Society. It is outside the County boundary, and also not very accessible, being nearly five miles from the nearest railway station, Rickmansworth. It is situated on the ridge of a hill overlooking the valley of the Chess, which river rises near Chesham in Buckinghamshire, and falls into the Colne at Rickmansworth in Hertfordshire, dividing the two counties for a distance of about three miles in the middle part of its course. Here it runs between the parishes of Cheneys and Flaunden, the latter being in Hertfordshire.

The day was devoted to the meeting, the members (about five-and-twenty) assembling at Rickmansworth station at eleven o'clock. The route taken was through Rickmansworth and Loudwater Parks, and across the meadows by the side of the river Chess to within half a mile of Cheneys. Here the hill was ascended by a path through the woods, which extend from the village to the river. Luncheon, with which the members had provided themselves, was here partaken of, trees recently felled being brought into requisition for seats.

On arriving at Cheneys, the church, dedicated to St. Michael, was visited. It is chiefly interesting as containing a chapel which has been the burial-place of the Russell family since 1556, and in which are some magnificent tombs of the Dukes of Bedford. In the church also are some brasses to the Cheynes. The adjoining Manor-house of the Sapcotes, where Queen Elizabeth was entertained in 1570, a very picturesque old building, was next inspected.

A walk of about a mile through the woods along Lady Cheynes' Walk, and across the river, brought the party to the ruins of the old church of Flaunden, in Hertfordshire. It is a very small church, cruciform in plan. The roof is now gone and also the east wall and the four arches formerly supporting a square central tower. The most perfect parts remaining are the west doorway and the south transept window, which contains three lights, and is of good Perpendicular style. The south transept was formerly a

chapel. The north transept window is of later date, the style being Tudor.

Salmon, in 1728, says: "The Church stands in a small Valley by a Brook's Side, surrounded by the Duke of *Bedford's* Woods, called *Cheyney* Woods. It is hard for a stranger to find. And the Curate, for want of Endowment, can't himself find the Way thither more than one *Sunday* in a Month, and that in an Afternoon." * And Cussans, writing in 1879, adds: "And so it continued within the memory of people now living." And he relates, of the adjoining parish of Bovingdon: "On the appointed fourth Sunday, if the weather were fine, a man was stationed on the top of the tower of Bovingdon church, whence he commanded a view of the road leading from Hemel Hempstead. If he saw the parson or his curate approaching, he would descend and ring the bell to summon the parishioners to church. If it rained or snowed, it was quite unnecessary to place a man on the look-out. It sometimes happened that for three consecutive months there was no divine service held either at Flaunden or Bovingdon." †

On leaving the old church, a different route was taken back to Cheneys, and after having tea here, the members returned along the high road by Charley Wood Common to Rickmansworth station.

Ordinary Meeting, 15th April, 1885, at Hertford.

C. E. Shelly, B.A., M.B., Vice-President, in the Chair.

The following papers were read:—

1. "Meteorological Observations taken at Throcking, Herts, during the year 1884." By the Rev. C. W. Harvey, M.A., F.R.Met. Soc. (*Transactions*, Vol. III, p. 239.)

2. "Report on the Rainfall in Hertfordshire during the year 1884." By the Rev. C. W. Harvey, M.A. (*Transactions*, Vol. III, p. 247.)

3. "Report on Insects observed in Hertfordshire during the year 1884." By F. W. Silvester, F.R.Met.Soc. (*Transactions*, Vol. III, p. 233.)

Field Meeting, 16th May, 1885.

HERTFORD AND WARE.

Seven years ago, on the 16th of June, 1878, the Society visited the neighbourhood of Hertford and Ware for geological investigation. Then, as now, the field meeting was held in conjunction with the Geologists' Association of London, and much the same route was taken as on the present occasion. At the former visit the geological features of the district were explained by Professor Morris. The present meeting was under the direction of Mr. Hopkinson.

The members of the two Societies arrived at Hertford station in two detachments, the first at 12 o'clock, the second at 1. The

* 'Hist. Herts,' p. 118.

† 'Hist. Herts.,' Dacorum Hundred, p. 179.

first section visited Hertford Castle, examining the old ruins and the "Castle Mound" by the side of the River Lea. The present building is of comparatively recent date, but the original castle is supposed to have been erected in the time of Alfred the Great or of Edward the Elder. It was much strengthened at the time of the Conquest, and considerable portions of the boundary-walls still standing probably date from that time.

On leaving the Castle the route taken was through the chestnut avenue in All Saints' churchyard, and from there through Balls Park (by permission of Mr. Faudel Phillips) to Mr. Lines's brick-fields near Rush Green. The second section came direct here by the London Road, the united party numbering between 30 and 40.

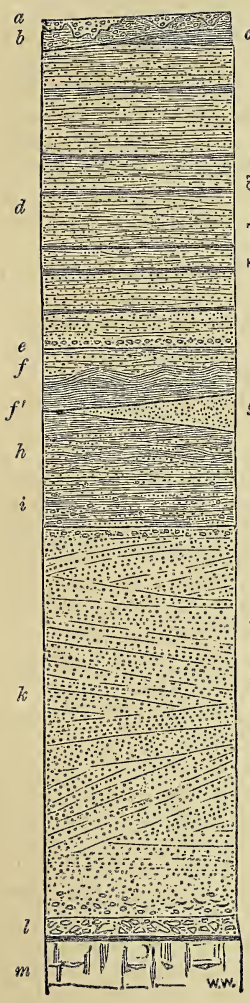
The beds exposed at these brickfields and in an old chalk-pit near them consist of a small portion of the Upper Chalk, with a very irregular surface due to its unequal chemical dissolution; the usual layer of flints with some flint-pebbles in sand; a very variable series of sands and clays representing the Woolwich and Reading beds; the basement-bed of the London Clay with part of the London Clay itself; and above these stratified deposits an irregular bed of pebble-gravel filling up depressions in the London Clay.

From a point where all these beds except the Chalk and its surface-layer of flints could be seen, the Director gave a brief description of them, prefacing his remarks with some general observations on the London Tertiary Basin.

It may, he said, be well to explain that the term "basin" is here used as a convenient expression for a series of beds originally deposited horizontally and subsequently let down in the centre by the sinking of the subjacent strata. The London Basin, therefore, is not a hollow in the Chalk in which the Tertiaries were deposited, in which event the surface of the Chalk would be curved and the Tertiaries would be horizontal, but it is a series of strata the members of which are conformable to, or parallel with, each other, and have only a very slight curvature caused by a folding or waving of the strata, which occurred after, and probably soon after, the deposition of the Eocene or Lower Tertiary beds. The same movement which caused a slight sinking of the Chalk and Tertiaries under London probably caused the slight elevation of the Wealden dome in the Kentish area, or that may have been of earlier date, taking place during instead of after the Eocene period. It must not however be inferred that the Chalk, after its quiet deposition by organic agencies in an ocean-bed, remained submerged throughout its extent until the lowest Tertiary beds, the Thanet sands, were deposited upon it, for a considerable area of it at least was probably for some time dry land, rising from the bed of the ocean and being subjected to denuding agencies, such as rain and rivers, similar to those now existing. In this neighbourhood there is evidence of a large amount of chalk having been washed away, and of the flints having been washed out of it, broken up, rolled into pebbles, and dispersed over wide areas, before it sank altogether beneath the ocean. The Thanet sands are absent here, but

General Section at Mr. Lines' Brickyard (George's Farm), near Rush Green, one mile E.S.E. of Hertford.*

(Scale, 8 feet to an inch.)



FEET.

(*a*) Small pipes of gravel, in parts.
(*b*) Thin wash of London Clay, with flints and pebbles, chiefly at the N.W. end.

(*c*) Dark brown clay; very little, and at the S.E. end only.
(*d*) Basement-bed. Brown bedded sandy clay and (in lower part) clayey sand, with thin layers of clay. Green grains here and there, and small ferruginous concretions . . . At the bottom a layer of black flint-pebbles (*e*) . . . . . about 12½

[The above is a long section; its continuation downwards is from smaller pits just below.]

(*f*) Pale grey and brownish sand and clay, irregularly resting on, or passing down into, very pale greenish ochreous clay (*f'*) . . . . . 2 to 3
(*g*) Pale lilac firm fine sand, thinning out at the N.W. . . . . 1½ to 0
(*h*) Purple, grey, red, and brown mottled clay, in parts sandy; passing into the bed below . . . . . 2 to 3
(*i*) Pale grey sandy clay with some small flint-pebbles; passing into the bed below . . . . . nearly 2

(*k*) Light-grey sand streaked with brown, false-bedded; with an interrupted layer of small flint-pebbles close to the top . . . . . 16 (or more.)

(*l*) Flints (some large) and flint-pebbles in sand.

[(*m*) Chalk.]

* Whitaker, 'Mem. Geol. Surv.,' vol. iv, p. 227, fig. 58.

they are largely developed south and east of London, and extend northwards to the borders of Essex and Suffolk, and possibly almost into Hertfordshire, north of Bishop's Stortford. The higher beds of the Upper Chalk are also absent, and it is therefore probable that the Chalk was for a longer period dry land here, and on the north-western margin of the London Basin generally, than on the south-eastern margin, either from its greater elevation or later depression, having therefore been subjected to denudation for a greater length of time. The character of the next succeeding deposits here seen, the Woolwich and Reading Beds, bears out this hypothesis, for they are more fluviatile or estuarine than they are to the south-east, where they repose on the marine Thanet Sands. The Lower and main portion of the Reading Beds here exposed consists of false-bedded sand, showing that it was subjected to strong currents, and therefore furnishing additional evidence of the proximity of land.

The section was then compared bed by bed with Mr. Whitaker's description of it as it appeared in 1869 (see p. lxvii). With the exception of a slight difference in the thickness of the highest beds of the Reading series, the only alteration since then appeared to be that there is now a continuous section from the London Clay downwards, the "smaller pits" mentioned by him being merged into one large pit communicating with that in which the London Clay is exposed. Very different it appears to have been in 1854 when examined by Professor Prestwich, who gave the following section :*—

		feet.
Basement-bed of the London Clay.	Mixed clay and gravel	1
	Brown sandy clay laminated with tougher clay, containing casts of *Panopæa*, etc	6
	Flint-pebbles in clay	0½
Woolwich and Reading Series.	Light greenish sand	4
	White or ash-coloured sand	6
	Light yellow sands	4
	Light-coloured mottled red and grey clays	10?
	Yellow sand with patches of *Ostrea Bellovacina* in places at its base	6?
Chalk.	Green-coated flints	1

In the basement-bed of the London Clay have been found *Panopæa intermedia*, *Pectunculus plumsteadiensis*, undetermined species of *Cardium*, *Astarte* (?), *Fusus*, and *Ostrea*, and teeth of *Lamna*.†

After some time had been devoted to an examination of this section, the party left the brickfields and walked by way of Rush Green and the picturesque "Walnut-tree Walk" to a large chalk-pit on Amwell Hill, and from there to Amwell Magna or Great Amwell (Emmewell or Emma's Well of Domesday Book), where a powerful spring rises from the chalk, augmenting the water of the New River.

* 'Quart. Journ. Geol. Soc.,' vol. x, p. 92.
† Prestwich, *loc. cit.*, vol. vi, p. 271.

Amwell Hill was formerly the site of a British encampment, which has very recently been demolished. "This rude British fortress was at a later period occupied successively by the Romans and Danes, the latter being driven out by King Alfred. The importance of the position is evident from the fact that on its northern and eastern fronts it formed a strong natural fortress commanding the navigation of the Lea, and adjoined the Ermine Street on the west." *

Coming to more recent times, Amwell is a spot of classic interest, for it always will be associated with the memory of old Izaak Walton, who made it the scene of his first lessons in angling. "On Amwell Hill, before sunrise, Piscator kept tryst with his friend Venator, and having, as he relates, merrily killed a bitch-otter and her helpless young ones . . . . . they adjourned to an honest ale-house . . . . . before commencing the more serious business of the day, on the banks of the River Lea."†

Amwell is also of interest in connection with the origin of the New River Company, of which Cussans gives the following account:‡— "In 1609, Hugh Myddleton, goldsmith, of London, and M.P. for Denbigh, his native town, proposed to the Corporation of London to bring a stream of water from Amwell and Chadwell to Islington, at his own expense. The Corporation gladly accepted his offer, and in May, 1609, the work was commenced . . . . . ." Owing chiefly to the opposition of landowners, "Myddleton had only completed about one-fourth of the distance, at an expense of about £3000, when he was compelled to petition the King for a royal grant, in order to finish the work. James [I.] acceded to Myddleton's request, and on the 2nd of May, 1612, entered into an agreement to pay one-half of the expenses already incurred, as well as of the future expenses, receiving in consideration therefor, a 'moiety of the interest in, and profits to arise from, the New River for ever.' . . . . . The total amount paid by the Crown, extending over a period of four years, was £8609 14*s.* 6*d.*," one-half of the expense. "At length, on Michaelmas Day, 1613, the great work was completed, and the Hertfordshire water flowed into the reservoir—it was called a 'cistern' then—at Islington." . . . . . "On the 21st of June, 1619, the shareholders were incorporated into a company, of which Sir Hugh—he had been knighted on the completion of the work—was elected Governor. The number of shares was 72, half of which belonged to Sir Hugh, and the other half to the King. The former, however, had disposed of all his shares except two." It was 20 years before the first dividend was declared, and that was only £15 3*s.* 3*d.* per share, or about 6 per cent. "For some years the affairs of the Company remained in an unsatisfactory state; the wooden troughs and conduits required constant repairs, and Charles I., who was sorely pressed for money,

* Cussans, 'Hist. Herts,' Hertford Hundred, pp. 119-120.
† *Ib.*, p. 120.
‡ 'Hist. Herts,' Braughing Hundred, pp. 145-147.

offered his 36 shares to the Company." They were accepted at £500 per annum, which is still paid. So much has the property increased in value, that while the Crown receives scarcely £14 per share, each share is probably worth at the present time at least £1000 per annum.

On leaving Amwell, the New River and Lea Navigation, which here flow through a wide flat of river-gravel, were crossed by the bridges, and the River Ash by a ferry, the party being taken across in four detachments. Easneye Park Wood was then entered, Mr. T. Fowell Buxton here meeting the members and conducting them to his residence, where they were most hospitably entertained. After refreshments had been partaken of, Mr. Buxton's collection of rocks and fossils was inspected and his extensive gardens and conservatories were visited. In the conservatories chrysalides of the swallow-tail butterfly (*Papilio machaon*) were being reared, the bright-coloured imagos of which will hatch out a little later in the season. Mr. Buxton's palatial residence is beautifully situated in the midst of a wood on a hill overlooking the valleys of the Lea and Ash, a portion of the wood having been cleared for the house and gardens. The bluebell being in full flower, on every side extended a carpet of blue, relieved here and there by clumps of the white narcissus, which had been purposely planted.

On leaving the house, a route was taken through Easneye Park to where it overlooks the valley of the Ash, and the party proceeded across this valley, by Widbury Hill, where some small chalk-pits were seen, to Ware. The extensive brickfields between Ware and Ware Park were crossed, but there was not time to examine the brick-earth beds nor the gravel-pits adjoining them on the hill-side to the north, which are of sufficient interest to be visited on another occasion. Ware Park was then entered, and its fine old avenue traversed, Hertford station being reached in time for the 6·50 train. The distance walked was about twelve miles.

Field Meeting, 20th June, 1885.

CASSIOBURY PARK, WATFORD.

A Field Meeting in Cassiobury Park, with a visit to the gardens of Cassiobury House, is always attractive, and this meeting was the most numerously attended of any in the year.

The members, numbering about 40, assembled at the principal entrance to the park at half-past two, and crossed the park, a few driving, but by far the larger number walking, to the Swiss Cottage grounds. Here some time was spent in viewing the trees, of which there are some finely-grown specimens and others of considerable rarity, and in looking for plants and insects of interest. The small-flowered balsam (*Impatiens parviflora*) was found here in as great profusion as ever, and a rather rare moth, known as the "peach-blossom," was captured "at rest" on a lady's dress, but the weather being cold and cloudy it was not a good entomological day.

After crossing the river Gade and the canal, the far park was entered, and the avenue leading towards the old lodge, long since demolished, was taken for some distance. Whippendale Woods were then entered, and after strolling through them the party returned across the park. The avenue facing Cassiobury House, which is crossed at right angles by the avenue previously mentioned, was first traversed, the lock-gates on the canal and the river bridge were crossed, and after a little further walk the extensive and beautiful gardens of Cassiobury were visited, by the kind permission of the Earl of Essex. These gardens are said to have been laid out by the celebrated Le Nôtre, under whose directions the gardens of Versailles were formed. The ornamental trees are remarkably fine, the Coniferæ especially; some of the cedars are supposed to be 200 years old. At this time of the year the gardens and conservatories are in perfection.

The gardens were left by the picturesque wood-walks and the old coach-road through them for Ashlands, the residence of the President of the Society, Professor Attfield, F.R.S. Here the members, whose number had considerably increased, were most hospitably entertained by the President, who had accompanied them in their walk, and Mrs. Attfield, and after tea and coffee and other refreshments had been partaken of, the picturesquely laid-out and well-kept gardens of Ashlands were strolled through, the party dispersing at about seven o'clock.

Field Meeting, 17th October, 1885.

BRICKET WOOD.

For the last three years a Cryptogamic Meeting or "Fungus Foray" has been held in the autumn, and on each occasion the members of the Society have had the advantage of the presence of Dr. M. C. Cooke and other mycetologists. At this meeting, however, there was unfortunately no one present who could identify the fungi, but, as at the cryptogamic meeting in the spring of this year, Dr. Braithwaite, F.L.S., and Mr. E. M. Holmes, F.L.S., kindly gave their services, accompanying the members, and determining the mosses and some other cryptogamic plants found.

The members assembled at Bricket Wood Station in two detachments, the first, from Watford, waiting for about half an hour for the second, from St. Albans. The united party then strolled through Bricket Wood to the Watford and St. Albans road, thoroughly exploring its cryptogamic vegetation, and, traversing this road for a short distance to the south, returned to the station along the bye-road which runs for some distance between this part of Bricket Wood and the "Scrubbs."

Although no record was made of the flowering plants seen in the course of the walk, it was observed that an unusual number of those which generally flower only in the spring were in bloom. Amongst these, *Geranium Robertianum* was specially noticed as having its petals very brightly coloured.

The fungi were found to be in great variety and profusion, more so than at either of the previous "Forays," but, although a great number of species were collected and forwarded to a mycetologist for determination, no list of them has yet been received.

The lichens were not so well represented, but the following species were detected by Mr. Holmes.

Collema pulposum, Bernh.
Calicium melanophæum, Ach.
,, *hyperellum*, Ach.
Evernia prunastri, L.
Parmelia caperata, L.
,, *Borreri*, Turn.
,, *perforata*, Wulf.
Lecanora subfusca, L.
Pertusaria fallax, Pers.
,, *globulifera*, Turn.
Phlyctis argena, Ach.
Lecidea quernea, Dicks.
,, *parasema*, Ach.
Graphis scripta, Ach.

Of the mosses about the same number of species were observed as have before been noticed at this time of the year, the following being additions to the Hertfordshire Moss-flora:—*Sphagnum intermedium*, *Entosthodon ericetorum*, and *Webera albicans*. Mr. Holmes gives the following list of species determined by Dr. Braithwaite and himself, the three additions to the county list being distinguished by an asterisk.

ACROCARPI.

Sphagnum intermedium, Hoffm.*
Dicranella heteromalla, Hedw.
Dicranum scoparium, L.
Pleuridium subulatum, L.
Pottia truncata, L.
Barbula muralis, L.
,, *revoluta*, Schwg.
Ceratodon purpureus, L.
Entosthodon ericetorum, Bats.*
Webera carnea, L.
,, *albicans*, Wahl.*
Bryum murale, Wils.
,, *capillare*, L.
Mnium undulatum, Hedw.
,, *hornum*, L.
Atrichum undulatum, L.
Polytrichum commune, L.
Fissidens taxifolius, L.

PLEUROCARPI.

Homalia trichomanoides, Schreb.
Anomodon viticulosus, L.
Thuidium tamariscinum, Hedw.
Isothecium myurum, Poll.
Brachythecium glareosum, B. & S.
,, *albicans*, Neck.
,, *rutabulum*, L.
Eurynchium striatum, Schreb.
,, *piliferum*, Schreb.
,, *Swartzii*, Turn.
,, *prælongum*, Dill.
Plagiothecium denticulatum, L.
Hypnum filicinum, L.
,, *cupressiforme*, L.
,, *purum*, L.
Hylocomium splendens, Dill.
,, *squarrosum*, L.
,, *triquetrum*, L.

Mr. Holmes also records the following Hepaticæ (scale-mosses):—*Lophocolea bidentata*, L., *Diplophyllum albicans*, L., and *Fossombronia pusilla*, Nees.

TRANSACTIONS

OF THE

HERTFORDSHIRE NATURAL HISTORY SOCIETY.

I.

THE DIATOMACEÆ; WITH SPECIAL REFERENCE TO SPECIES FOUND IN THE NEIGHBOURHOOD OF HERTFORD.

By Isaac Robinson.

Read at Hertford, 29th November, 1883.

At some of the previous meetings of the Society I have had the pleasure of showing specimens of the Diatomaceæ under the microscope, and I have when doing so been frequently asked, "What are Diatoms?" I therefore thought we might suitably devote an evening to the study of these minute organisms, though I fear the subject is one which is but little known to our members, and one in which consequently but little interest is felt. I hope, however, to be able to show that it is a subject which not only deserves a careful study, but which also amply repays it. I believe, also, that our own locality in the neighbourhood of Hertford, abounding as it does with rivers and streams, is particularly well adapted to the prosecution of such a study, and likely to yield exceptionally good results. Such has indeed been my own experience, and I think some of the facts which I shall adduce will fully bear out this opinion.

Our knowledge of this branch of Natural History is, comparatively speaking, of very recent acquisition. So minute are the individual forms of the Diatomaceæ that they are invisible to the naked eye, and we are therefore entirely dependent upon the microscope for our knowledge respecting them. If we look back to the time of Shakespeare, we shall find it necessary to include them amongst those subjects of which Hamlet says:—"There are more things in Heaven and Earth, Horatio, than are dreamt of in our philosophy." For many years after Shakespeare's time diatoms still remained undreamt of, indeed they do not appear to have been

definitely observed until so recently as 1745. In that year a Mr. William Arderon, F.R.S., discovered in a ditch in Norwich what he termed the "oat-animalcule," probably one of the *Naviculæ* now so well known. A few other forms were subsequently discovered, until, in the year 1824, Agardh published his 'Systema Algarum,' and recorded 49 species comprised under 8 genera. With the subsequent rapid advance in optical science, and the great improvements effected in the construction of the microscope, the additions made to the list of known species were very numerous, and at the present time those of Europe alone are to be reckoned not by hundreds but by thousands. The subject has also proved itself to be of so interesting a character to microscopists that a large amount of literature has grown up in reference to it. The best work descriptive of British species is the synopsis of Prof. Smith, which however was published from 25 to 30 years ago, and must therefore now be considered incomplete in consequence of the great number of species which have since been discovered.

It was for many years a disputed point whether the Diatomaceæ should be classed in the animal or in the vegetable kingdom. The free condition of many of the forms, and their distinct power of independent motion, seemed to the earlier observers to indicate their animal character. The present generally-received opinion, however, formed after a much more extended and careful study, is that their proper place is in the vegetable kingdom. They are therefore now considered to be minute plants, and they are classed amongst the Cryptogamia, forming an order of the sub-class Algæ.

The distinctive characteristic of these plants is the possession of an almost indestructible siliceous external covering or shell which is usually termed a frustule or valve. These frustules exist in pairs, thus forming a protection to the living cell of the diatom, which is placed between them. They may for the sake of illustration be compared to the shell of an oyster, or other bivalve, the body of the oyster representing the living cell of the diatom, and the shell the two frustules. The diatom, however, does not possess a hinge-like connecting membrane as the oyster does, but the two frustules are connected round their edges by a band of silica corresponding to the width of their separation. Apertures are provided in this flinty covering for the necessary communication with the surrounding water.

The great interest of the Diatomaceæ to the microscopist consists in their infinite variety of form and in the beautiful and wonderfully-delicate markings which are found upon them. Their indestructibility also confers upon them a special value, as they may in consequence of it be preserved for reference without deterioration, and they supply some of the most beautiful objects we possess for microscopic examination. Their shape is exceedingly various. Some are perfectly circular in form, others oval, triangular, square, many-sided, crescent-shaped, or boat-like. Some are perfectly straight and needle-like, and far sharper than any needle fashioned by human hands. Others are curved or sigmoid, the curves taking

opposite directions, and somewhat resembling the letter S. Others are irregular in form, and one of the most beautiful found in our own locality, *Campylodiscus costatus*, bears a very close resemblance in shape to a saddle.

But an equal, if not indeed a greater interest attaches to the markings found upon their surfaces. These are of great diversity, though constant in the same species. In some they consist of very fine lines called striæ, perfectly straight and parallel, and executed with the greatest mathematical precision. These lines when subjected to examination under a sufficiently high power are found in some cases to consist of separate bead-like dots, and are in consequence termed moniliform, while others appear simply as ridges on the surface. If we examine a valve of *Pleurosigma attenuatum*, a very frequent form in this locality, we shall find that it affords an excellent illustration of the dotted lines just referred to. The dots form rows corresponding lengthwise with the curve of the valve, and they are so placed that shorter rows are also formed at right angles across its surface. It is found that there are 40 of these dots in one-thousandth of an inch. If however we examine a marine species of the same genus, *Pleurosigma angulatum*, we shall find that the rows are arranged diagonally, and cross each other obliquely at an angle of about 60°. The dots also are very much closer together and count 52 to the thousandth of an inch, and, although a single frustule will show many thousands of them, yet so perfect is the arrangement that not one can be detected as misplaced. When examined under a very high power these separate dots are found to be of a hexagonal form. These objects are frequently made use of as tests of the quality of microscopical lenses. The most crucial test, however, in this way is the valve of *Amphipleura pellucida*, which also is frequently found near Hertford. In this species the lines are of extreme delicacy and so closely placed that about 100 are found to exist in one-thousandth of an inch, and even these lines are found to consist of dots placed at regular intervals at the rate of 84 to one-thousandth of an inch.

The cellular arrangement of many diatoms also claims our notice. Some of these minute plants seem to be endowed with the ability to solve most difficult geometrical problems. For instance a triangular species, *Triceratium Favus*, fills up its central part with a most perfect series of hexagonal cells, placing however a pentagon here and there in the solution of the difficult question of adapting the two geometrical figures to each other. Many of the circular forms are also filled up in the same manner.

The minute size of these organisms is very remarkable, especially when considered in connexion with their marvellous perfection of form and detail. The actual size of some of the individual forms of the largest species is about one-fortieth part of an inch in length, but these must be looked upon as veritable giants amongst their fellows. The majority are very much smaller. Some of the circular and oval forms common in this district measure only about one-thousandth of an inch

in length or diameter. Now it is very easy to speak of these small dimensions, but by no means so easy to realize them. An illustration may however help us to do so. Let us take a specimen of *Surirella minuta*, which, though measuring only one-thousandth of an inch in length, is most distinctly and regularly marked round its margin. If we measure the thickness of an ordinary sheet of note paper, we shall find that it is equal to about $\frac{1}{2\,5\,0}$th of an inch. If therefore we place four specimens of *Surirella minuta* in a row, the length of that row will exactly equal the thickness of the note paper.

For the sake of a practical illustration of the exceeding minuteness of these forms, I have mounted some of them upon a slide together with a very small needle, of the size known to ladies as No. 10. When placed under the microscope several hundreds of diatoms, comprising many different species, may be seen within the eye of that needle.

The number of frustules which may be contained in a single drop of water is, as may be imagined, very great. I have a slide of *Achnanches subsessilis* mounted from specimens which I found in my own garden at Hertford, and which comprises the contents of one single drop only, but which a careful estimate has shown to number upwards of 200,000 separate frustules. Another mount, of *Achnanches exilis*, a smaller form which I found in a ditch by the railway between Hertford and Ware, prepared in the same way and comprising the contents of only one drop, afforded a still more astonishing result. In this case the number of frustules contained in the one drop was found to be about 430,000. In each of these instances the diatoms occupied but a fraction of the entire bulk of the respective drops, probably not more than $\frac{1}{2\,5}$th part. I arrive at this conclusion because I find that in the small phials in which these specimens are preserved, and which contain a depth of about $1\frac{1}{2}$ inches of water, the diatoms when allowed to settle form only a thin stratum of from $\frac{1}{1\,5}$th to $\frac{1}{2\,0}$th of an inch in thickness. The total bulk of a drop of water would therefore in the former instance represent the aggregate size of five millions of frustules, and in the latter that of upwards of ten millions.

It will of course be very obvious that in order to obtain a correct knowledge of these minute forms, we must make use of the highest available powers of the microscope. In prosecuting the study of local species I have been accustomed to employ two objectives, one of half an inch focus, giving with the "B" eye-piece a magnifying power of 180 diameters, and the other of $\frac{1}{1\,2}$th inch focus, giving with the same eye-piece a power of 750. I have used these on what is termed a nose-piece, and they are so arranged that they are exactly interchangeable, so far as focal distance is concerned, and the different illumination required by the two powers is easily accomplished by means of a Webster's condenser. This has proved to be a most convenient arrangement.

The magnifying powers just mentioned are, however, in one direction only, but as length and breadth are both equally extended,

we shall perhaps obtain a better idea of the result if we consider what the superficial amplification amounts to. This in the case of the half-inch objective would amount to about 32,000 times, and with the $\frac{1}{12}$th inch to upwards of 560,000. Let us for a moment imagine it possible to subject one of our own species to such an amplification as is represented by these powers. Take, for example, a man 6 feet in height. Under the lower scale of amplification he would acquire an apparent stature of upwards of 1000 feet, and under the higher power one of 4,500 feet, or a greater elevation than the highest mountains in Britain.

These powers are, however, by no means excessive for the efficient study of the forms and marking of the Diatomaceæ. I have, indeed, sometimes subjected them to a far higher degree of magnification, having obtained a linear amplification of about 5000 diameters, or a superficial enlargement of about 25 millions of times. But, to whatever extent this process is carried, no trace of imperfect workmanship can be discovered, the minutest detail being invariably found to be executed with unerring exactness and precision.

The power of spontaneous motion possessed by the free forms has already been referred to. This motion is of a peculiar character. In many cases it consists of a series of jerks, and after a short space has been traversed the path is usually retraced. It has a peculiarly undecided and aimless appearance, and reminds one of the uncertain steps of a man suffering from the evil effects of "the sweet poison of misused wine." It seems to be of a purely mechanical character, and there is no trace of the power of self-direction which is usually possessed by animal natures. The means by which it is accomplished are also unknown to us, and remain an unsolved enigma to the present hour, for the microscope with all its wonderful revelations has not yet disclosed them.

We pass on now to a brief consideration of the mode of reproduction amongst the Diatomaceæ, and to that marvellously rapid increase in numbers which characterizes them. The usual manner in which this is accomplished is by the process termed self-division, a mode of increase which takes place amongst many other organisms. By this process one single cell becomes two cells exactly similar to and as perfect as the original one. These two cells again divide, and so the increase of numbers proceeds with a constantly augmenting rapidity. The exact time occupied by this act of self-division is not known, but Professor Smith supposes it may be accomplished in 24 hours. Should such be the case, he calculates that the progeny of a single diatom would in one month amount to one thousand millions. This process cannot, however, be regarded as a true generic reproduction, but rather as one of gemmation, and analogous to the growth of a tree leaf by leaf. Neither does it appear that it can be continued indefinitely. After a time the requisite energy becomes exhausted, and an altogether different process supervenes, resulting in the formation of what are termed sporangia, and in the origin of a new generation. The circumstances

attending this process, which may be regarded as more nearly allied to that prevailing in the higher forms of vegetable life, are, however, involved in much obscurity.

These organisms are very widely distributed over the surface of the earth. They are to be found in all latitudes and under almost every condition of climate and temperature. They abound in arctic, tropical, and antarctic regions. In the Botanical Journal of the Linnean Society for September last was published an account of a gathering of fresh-water species found at or near Cape Sabine, situated in the arctic regions in latitude 78° 40′ north. This gathering contained 30 distinct species, and in looking through the list I find that I have myself found at least 10 of them in our own locality. Some of the others, which are more characteristic of mountainous districts, I have also found abundantly in Switzerland and elsewhere. This affords a good illustration of the cosmopolitan character of many species. Prof. Smith states with reference to three of these, which are to be found in abundance near Hertford, viz. *Synedra radians*, *Pinnularia viridis*, and *Cocconema lanceolatum*, that they have been found in gatherings from many parts of Europe; from Smyrna, Ceylon, the Sandwich Islands, New Zealand, and New York; from the loftiest accessible points of the Himalayas in Asia, and of the Andes in America. Another form, *Epithemia gibba*, stated to be an inhabitant of the geysers of Iceland and the lakes of Switzerland, is to be found abundantly in the King's Meads between Hertford and Ware.

The Diatomaceæ are to be found in about equal abundance in salt water, in fresh water, and in brackish water. The marine forms are, however, never found in fresh water, nor are the fresh-water forms ever found in the sea, unless carried thither by the action of rivers or other causes. Certain forms are found almost exclusively in brackish water.

In our own district the fresh-water forms abound in every river, stream, ditch, and pond, and the student need fear no lack of material for study. His difficulties are more likely to arise from a superabundance, from the great and perplexing varieties of form so constantly met with, and from the labour of reducing them to order and classification. The number and variety of species frequently found together in a very small space is a matter of much surprise. Thus a single drop of water may contain perhaps 20 different kinds naturally associated together and jostling each other in the struggle for life.

Whether or no it be true as it is said that fleas have their little fleas I cannot say. I can, however, state that large diatoms have their little diatoms. It is by no means uncommon to see a large specimen well-nigh covered with a number of small ones affixed to it parasitically, or more correctly in a state of commensalism. I met with a curious illustration of this arrangement a few months ago in the case of a large *Surirella* which I found in the ditch by the Warren at Hertford, and which had to bear the burden of a large growth attached to it of a smaller form known as *Odontidium parasiticum*.

In order to convey some idea of the abundance and variety referred to, I may instance a collection I made from the old River Rib, near Hertford, in September, 1883. This collection consisted of a small quantity of dirty and repulsive-looking scum which was floating on the surface of the water, and which I took home in a small bottle in my pocket. A subsequent careful examination under the microscope enabled me to identify no less than 56 distinct species contained in it. Another collection from an isolated pond in a field near Brickendon yielded 26 species, whilst others from the river Ash and the adjoining pond at Easneye, made on the occasion of the Society's field meeting there last June, yielded 44 species. These statements are sufficient to indicate the very wide and general distribution of these forms. They may also be found in some places in which their presence would appear far less probable. Thus in the early part of last October I found in the saucer of a flower-pot, containing a large plant of *Agapanthus umbellatus* which had been standing in my garden during the summer, a large quantity of a rare form known as *Achnanthes subsessilis*, to which I have already referred. In the saucer of another flower-pot I found a considerable quantity of a totally different form known as *Nitzschia Amphioxys*. I have also found many beautiful marine forms in the stomachs of tinned oysters imported from America. These have been swallowed by the oysters with their food, but being incapable of digestion have remained uninjured. Many species are also to be found in guano. These have been swallowed by sea-birds with their food, and in consequence of their indestructibility have passed through their systems uninjured. It is however remarkable that such delicate forms should have escaped the action of their powerful gizzards, but probably their minute size has saved them.

Diatoms are also found in a fossil state, and in this condition they form strata of considerable thickness in various parts of the world. These strata have doubtless been formed in the beds of lakes, and consist of the accumulation of the frustules of countless generations. Various examples of this character exist in Great Britain, as for instance at Dolgelly in Wales, in the island of Mull in Scotland, and at Toome Bridge and elsewhere in Ireland. A more remarkable instance, however, is that of Richmond in Virginia, where the whole city is built upon a stratum of diatoms 18 feet in thickness, and one which contains many beautiful forms. Another very extensive deposit is found in Bohemia, where it occurs in beds of about 14 feet in thickness which supply the fine sand used for delicate castings. Another deposit found in Hanover is known as Kieselguhr or flint-mud. It has been found to possess the peculiar character of absorbing three times its weight of nitroglycerine, and is therefore made use of in the manufacture of dynamite. The preparation known as "Stevens's silicon," found in the State of Nevada and used for polishing jewellery, etc., consists almost entirely of the frustules of diatoms. Tripoli and rotten-stone, used for polishing, are similarly constituted. It

would indeed appear that notwithstanding their minute size the Diatomaceæ have added far more to the bulk of the earth's crust than all the gigantic animals of pre-historic times.

In treating of the classification of the Diatomaceæ I propose to follow the arrangement adopted by Professor Smith in his 'Synopsis of the British Diatomaceæ.' In this work he has described 465 species found in Great Britain. Of this number 239 are exclusively inhabitants of fresh water, 142 are exclusively marine, and the remaining 84 may be found in brackish water, but many of them are not so decided in their proclivities. He divided the whole of this natural order into two tribes. The first of these included all those forms the frustules of which are found in a naked condition and freely exposed to the surrounding water; and the second, those which are enclosed in membranaceous tubes or envelopes. The first of these tribes is by far the largest and most important. It includes 428 species out of the total of 465, and it is again divided into five sub-tribes in accordance with certain characteristics of growth. In the first of these sub-tribes the frustules are found either in a perfectly free condition, or simply adherent to some other substance. It is by far the most numerous of them, embracing 282 species, and representatives of it are very abundant in our own locality. In the second sub-tribe the frustules do not possess the power of free motion, but are attached to some other substance, either by means of a gelatinous cushion or a dichotomous stipe. In the third, the frustules are closely attached to each other, side by side, and in this way form filaments of considerable length. The filaments are modified in the fourth sub-tribe in consequence of the frustules being attached to each other by opposite corners only, and thus acquiring a zigzag form. In the fifth and last the separate frustules are circular in form, and when closely attached to each other by their surfaces produce cylindrical filaments. All these sub-tribes have representatives in our own district.

In the second tribe the separate frustules are usually enclosed in membranaceous tubes, and are often very closely packed in them in regular files. The aggregations of these delicate tubes often form fronds of considerable size, sometimes an inch or two in length, and give them the appearance of very fine Algæ. The majority of the species included in this tribe are marine, but some of those found in fresh water are frequent in this locality.

In conclusion I would commend the study of the Diatomaceæ to any who have the opportunity of pursuing it, for not only does it possess the fascination and charm of a new revelation respecting the world around us, but it will I believe enable us to form a very much higher mental ideal of the omnipotence of the Creator. In the marvellous variety and beauty of design which it affords, in combination with an absolute perfection of execution, notwithstanding an almost inconceivable minuteness in size, we find some of the very best possible illustrations of the "Wondrous works of Him which is perfect in knowledge."

LIST OF SPECIES FOUND IN THE NEIGHBOURHOOD OF HERTFORD.

Epithemia turgida
„ alpestris
„ gibba
Cymbella cuspidata
„ ventricosa
Amphora ovalis
Cocconeis Pediculus
„ placentula
Cyclotella Kutzingiana
„ rotula
Campylodiscus costatus
„ spiralis
Surirella biseriata
„ linearis
„ angusta
„ minuta
Tryblionella gracilis
„ angustata
Cymatopleura solea
„ apiculata
„ elliptica
Nitzschia sigmoidea
„ linearis
„ amphioxys
„ vivax
„ acicularis
Amphipleura pellucida
Navicula crassinervia
„ serians
„ cuspidata
„ rhynchocephala
„ firma
„ ovalis
„ minutula
„ affinis
„ inflata
„ gibberula
„ amphirhynchus
„ producta
„ ambigua
„ amphisbæna
„ tumida
„ cryptocephala
Pinnularia major
„ viridis
„ oblonga
„ lata
„ acuta
„ radiosa
Pinnularia gracilis
„ viridula
„ divergens
„ gibba
„ stauroneiformis
„ mesolepta
„ interrupta
Stauroneis Phœnicenteron
„ gracilis
„ acuta
„ anceps
„ linearis
„ truncata (Rab.)
Pleurosigma attenuatum
„ lacustre
„ Spencerii
Synedra lunaris
„ bi-lunaris (Kutz.)
„ radians
„ Ulna
„ obtusa
„ capitata
„ hamata
„ vaucheriæ
Cocconema lanceolatum
„ cymbiforme
„ Cistula
„ parvum
Gomphonema constrictum
„ acuminatum
„ cristatum
„ tenellum
„ capitatum
„ olivaceum
„ intricatum
„ Vibrio
„ curvatum
Meridion circulare
Odontidium mutabile
„ parasiticum
Achnanthes subsessilis
„ exilis
Diatoma vulgare
„ elongatum
Tabellaria flocculosa
Encyonema prostratum
„ cæspitosum
Colletonema neglectum
„ subcoherens

II.

THE RECORDED OCCURRENCES OF LAND AND FRESH-WATER MOLLUSCA IN HERTFORDSHIRE.

By W. Denison Roebuck, F.L.S., and John W. Taylor.

Communicated by J. Hopkinson, F.L.S.

Read at St. Albans, 10th January, 1884.

An accurate knowledge of previous writings on the subject, a comprehensive summary of the existing state of its literature, is at any time a desirable preliminary to the commencement of active research in any department of scientific investigation. It will therefore, we trust, be of some service to Hertfordshire conchologists to be possessed of such a sketch relating to the Land and Fresh-water Mollusca of the area of their investigations. More especially is this desirable at the present time, in view of the efforts which our friend Mr. Hopkinson is making towards the working out of the molluscan fauna of the county.

Towards this work, however, the published records yield but a slender contribution, and it is to be confessed that, so far as this department of natural science is concerned, Hertfordshire must be considered as having been, down to the present time, an unworked and much neglected county, notwithstanding the number of able and distinguished conchologists who have at times resided or collected within its limits. No records of their labours exist, so far as we are aware, save the few which we now proceed to recapitulate.

We judge it advisable to give, in the first instance, a list of books and papers in which reference is made to Hertfordshire Mollusca; and secondly, a systematic list of the species and varieties treated of, with an abstract or indication of the nature of the information given. The present paper, it may be hardly necessary to add, is confined in its scope entirely to printed and published records.

I.—List of Works containing References to Hertfordshire Mollusca.

1678.

Martini Lister, Historiæ Animalium Angliæ, tres tractatus. . . . alter de Cochleis tum Terrestribus tum Fluviatilibus. pp. 111, 112.—Cochlea cinerea, maxima, edulis, cujus os operculo crasso velut gypseo per hyemem clauditur=*Helix pomatia.*

1803.

Montagu (G.). Testacea Britannica, or British Shells. p. 407.—*Helix pomatia.*

1808.

Montagu (G.). Supplement to Testacea Britannica. p. 145.—*Helix Cantiana.*

1836.

Cooper (Daniel). Flora Metropolitana . . . with a list of the Land and Fresh-water Shells of the Environs of London. p. 126. —*Limneus auricularis*=*Limnæa auricularia*; *L. Scaturiginum*= ? *L. stagnalis*, junior; *L. fossarius* = *Limnæa truncatula*. p. 127. —*Paludina vivipara*=*P. contecta*; *P. achatina*=*P. vivipara*; *Neritina fluviatilis*; *Ancylus lacustris*.

1847.

Pickering (J.). Description of a remarkable species or variety of British Paludina: *Zoologist*, Vol. v, p. 1786.—*Paludina achatina*, var. *efasciata*, Pick.=*P. vivipara*, var. *unicolor*, Jeff.

1853.

Forbes and Hanley. History of British Mollusca, and their Shells. Vol. ii, p. 161.—*Anodonta cygnea*. Vol. iii, p. 10.— *Paludina Listeri*, F. and H., by error for *P. vivipara*, var. *efasciata*. Vol. iv, p. 136.—*Succinea putris* and var. *gracilis*=*S. putris* and *S. elegans*.

1862.

Jeffreys (J. Gwyn). British Conchology. Vol. I, Land and Freshwater Shells. p. 48.—*Dreissena polymorpha*. p. 58.—*Paludina vivipara*, var. *unicolor*=var. *efasciata*, Pick. p. 177.—*Helix pomatia*. p. 189.—*H. arbustorum*, var. *alpestris*. p. 298.—*Achatina acicula*.

1866.

Tate (Ralph). Land and Fresh-water Mollusks of Great Britain. p. 135.—*Helix pomatia*. p. 192.—*Limnæa stagnalis*, var. *fragilis*.

1873.

Ashford (C.). Zonites glaber (Studer): *Science Gossip*, vol. ix, June, 1873. p. 137.—*Zonites glaber*, *Z. cellarius*, *Z. alliarius*, and *Z. nitidulus*.

1875.

Harting (J. E.). Rambles in search of Shells, Land and Fresh-water. p. 29.—*Zonites glaber*.

1876.

Lavis (H. J. J.). [List of Mollusca collected in Berry Wood, near Aldenham, May 1st, 1875]: *Trans. Watford Nat. Hist. Soc.*, vol. i, part 4, June, 1876. p. xvii.—*Planorbis carinatus*, *P. corneus*, *Physa fontinalis*, *Limnæa peregra*, *L. stagnalis*, *Zonites glaber*, *Z. radiatulus*, *Helix aspersa*, *H. nemoralis*, *H. Cantiana?*, *Clausilia*, sp., *Cochlicopa*, sp.

1877.

Fordham (H. G.). Supposed recent extinction of Cyclostoma elegans in North Herts: *Trans. Watford Nat. Hist. Soc.*, vol. i, part 7, July, 1877. p. 172.—*Cyclostoma elegans*.

Jeffreys (J. G.). Helix villosa, Drap., new to Britain: *Ann. and Mag. Nat. Hist.*, Ser. 4, vol. xix, Feb. 1877. pp. 199–200. —*Helix arbustorum*, var. *alpestris*. Record repeated in *Journal of Conchology*, vol. ii, p. 298, Oct. 1879.

1878.

Jeffreys (J. G.). Notes on some British Land and Fresh-water Shells: *Ann. and Mag. Nat. Hist.*, Ser. 5, vol. ii, pp. 377–382, Nov. 1878. p. 378.—*Succinea putris, S. virescens.* p. 380.—*Vertigo Moulinsiana.*

1880.

Groves (Henry). On the Occurrence of Vertigo Moulinsiana, Dupuy, in Hertfordshire: *Trans. Hertfordshire Nat. Hist. Soc.*, vol. i, part 2, Dec. 1880, (with Plate). pp. 81, 82.—*Vertigo Moulinsiana, V. antivertigo.*

Rimmer (R.). Land and Fresh-water Shells of the British Isles. p. 3.—*Sphærium corneum*, vars. *flavescens, Nucleus*, and *Scaldiana.* p. 27.—*Paludina vivipara*, var. *unicolor.* p. 92.—*Succinea putris*, var. *vitrea=S. virescens.* p. 121.—*Helix arbustorum*, var. *alpestris.* p. 159.—*Vertigo Moulinsiana.*

1881.

Jeffreys (J. G.). [Remarks on a few species of Hertfordshire Mollusca]: *Trans. Hertfordshire Nat. Hist. Soc.*, vol. i, part 4, April, 1881. pp. xvi, xvii.—*Vertigo Moulinsiana, Succinea* [*virescens*], *S. putris*, and *S. elegans.*

Taylor (J. W.). Life-histories of British Helices [No. 1. H. arbustorum]: *Journal of Conchology*, vol. iii, Oct. 1881. pp. 247, 255.—*H. arbustorum*, var. *alpestris.*

1883.

Loydell (A.) and Rowe (E. H.). Conchologists' Report: *Report of the Lambeth Field Club and Scientific Society* for 1882–83, pp. 18–22. p. 20.—*Limnæa peregra, L. stagnalis*, and *L. palustris.* p. 21.—*Zonites glaber, Helix pomatia* var. *albida, H. nemoralis, H. hortensis, H. arbustorum, H. Cantiana*, and *H. sericea.*

Taylor (J. W.). Paludina vivipara, v. unicolor, Jeff.: *Journ. of Conch.*, vol. iv, Oct. 1883. pp. 127–128.—*Paludina vivipara*, var. *efasciata*, Pick.

II.—Catalogue of Species and Varieties of Hertfordshire Mollusca referred to in the above Works, with Annotations.

Sphærium corneum, var. flavescens (*Macgill.*); var. Nucleus (*Stud.*); var. Scaldiana (*Norm.*).

All these forms are recorded for Watford by Rimmer, on the authority of Rich.

Anodonta cygnea (*L.*).

Forbes and Hanley remark that they "need not specify any peculiar localities for a species so universally diffused throughout Europe, but may observe that several of the more remarkable forms [are obtained] in the river Lea, near the Metropolis."

Paludina contecta (*Millet*).

D. Cooper in 1836 recorded *P. vivipara* (=*P. contecta*) as found in the "New River" by Thomas Bell, James Carter, and himself.

PALUDINA VIVIPARA (*L.*).

D. Cooper in 1836 recorded *P. achatina* (=*P. vivipara*) as having been found in the "New River" by Thomas Bell.

PALUDINA VIVIPARA (*L.*), var. EFASCIATA, *Pick.*

Mr. Pickering described this form in the 'Zoologist' for 1847, saying of it: "The shell is very local, and by no means plentiful. I have taken it in slow streams in Hertfordshire for the last three years successively, but nowhere else. I have never met with any specimens that are intermediate between it and the strongly-banded ones, but, on the contrary, all the other specimens I have taken associated with it are the most strongly banded I have ever seen." Forbes and Hanley state that "A greenish white variety, without bands, has been found by Mr. Pickering, in the river Lea, Herts," but they erroneously refer this variety to their *P. Listeri* (*contecta*) instead of to this species. Dr. Jeffreys calls the variety *unicolor*, and observes: "The variety has been found by Mr. Pickering in Hertfordshire." Mr. Taylor in 1883 corrects Jeffreys' nomenclature as to this variety, and reproduces Pickering's original observations.*

DREISSENA POLYMORPHA (*Pall.*).

Dr. Jeffreys says that this species "has been found in the most frequented streets of London, after they have been flushed with water from the New River, where it abounds."

NERITINA FLUVIATILIS (*L.*).

Recorded in 1836 by D. Cooper as found "in the Thames and Lea abundantly" by James Carter, Thomas Bell, and himself.

PLANORBIS CARINATUS, *Müll.*; P. CORNEUS (*L.*).

Mr. H. J. J. Lavis found these in 1875, together with *Physa fontinalis*, *Limnæa peregra*, and *L. stagnalis*, "in a pond by the side of the road, just after crossing the river bridge (Bushey Mill)."

PHYSA FONTINALIS (*L.*).

Found by Mr. Lavis at Bushey Mill in 1875, with the preceding.

LIMNÆA AURICULARIA (*L.*).

Recorded in 1836 by D. Cooper as found "in Lea River" by Thomas Bell.

LIMNÆA PEREGRA (*Müll.*); L. STAGNALIS (*L.*).

Both these species were found by Mr. Lavis at Bushey Mill in 1875 in company with the *Planorbes*, etc., and in 1883 they are recorded for Puckeridge by Loydell and Rowe. The last-named species in its juvenile stage is probably the *Limneus Scaturiginum* which in 1836 Daniel Cooper recorded as having been found in the "New River" by James Carter.

LIMNÆA STAGNALIS, var. FRAGILIS (*L.*).

R. Tate remarks: "The variety is found in a few canals. I have met with it very elongated in the River Lea, at St. Albans." [The river is the Ver.—ED.]

* Dr. Jeffreys informs me that when he gave the name *unicolor* he was not aware of Mr. Pickering's publication, having received specimens from him without a name.—ED.

Limnæa palustris (*Müll.*).

Recorded for Puckeridge in 1883, by Loydell and Rowe.

Limnæa truncatula (*Müll.*).

Recorded in 1836 by D. Cooper under the name of *Limneus fossarius*, as found "in the Lea River" by Thomas Bell.

Ancylus lacustris (*L.*).

Recorded in 1836 by D. Cooper as found by Thomas Bell "in the Lea River."

Succinea virescens, *Morelet*.

In the Annals of Natural History (1878) Dr. Jeffreys remarks: "This is my variety *vitrea* of *S. putris* . . . I lately found a specimen at St. Albans with *S. putris*, but unfortunately I had no time to examine the animal further than by noticing that it seemed to be of a darker hue than that of *S. putris* or *S. elegans*. . . ." In 'Trans. Hertfordshire Nat. Hist. Soc.' (1881), Dr. Jeffreys gives the locality as "at St. Albans, on the bank of the river Ver, near the Great Northern Railway Station," where he says it occurs with *S. putris* and *S. elegans*.

Succinea putris (*L.*); S. elegans, *Risso*.

Forbes and Hanley, who reduce the latter form to a variety (*gracilis*, Ald.) of the former, write of them as follows: "Our friend, Mr. Pickering . . . remarks on some specimens of the two leading varieties taken in the neighbourhood of Hoddesdon, Herts, that *putris* occurs on the grass in damp meadows; *gracilis*, on aquatic plants and mud by the sides of streams and ditches; the former may occasionally be met with in the same situations as the latter, but I have never met with *gracilis* in those in which *putris* is usually found, *i.e.* in damp meadows." Dr. Jeffreys also found *S. putris* with *S. elegans* at St. Albans, as recorded under *S. virescens*.

Zonites cellarius (*Müll.*); Z. nitidulus (*Drap.*).

Found at Hitchin in the spring of 1873 by Ashford and Tuke, accompanied by the next species.

Zonites alliarius (*Miller*).

Under the heading of "*Zonites glaber*," Mr. Ashford wrote in 1873: "Mr. S. Tuke and myself took several specimens on the 30th ult., in woods near Hitchin, where it is found under long damp moss, associated with *Z. alliarius*, *Z. nitidulus*, and *Z. cellarius*. The shells taken are much darker than specimens I have received from Cheshire, being of a reddish-brown colour, and extremely glossy." The specimens thus placed on record were named *Z. glaber* by Dr. Jeffreys, to whom one or two were sent by Mr. Ashford. One of Mr. Ashford's specimens was afterwards submitted by Mr. Ponsonby to the judgment of Dr. O. Boettger of Frankfurt-am-Main, who pronounced it to be "decidedly *Z. alliarius*." In this determination Mr. Taylor (to whom the specimen seen by Dr. Boettger was afterwards sent and in whose possession it now is) concurs.*

* Dr. Jeffreys assures me that the specimens which *he* received from Mr. Ashford undoubtedly belonged to *Z. glaber*.—Ed.

ZONITES GLABER (*Stud.*).

In 1875 Mr. H. J. J. Lavis found it "near Otterspool, Berry Wood," in 1873 Mr. Ashford recorded it as found near Hitchin, and in 1883 it was recorded for Easneye by Loydell and Rowe. These records, or some of them, may appertain to the nearly-allied species *Z. alliarius*.

ZONITES RADIATULUS (*Ald.*).

Found by Mr. Lavis in 1875 near Otterspool, Berry Wood.

HELIX POMATIA, *L.*

The earliest record is that by Martin Lister in 1678, who writes: "Agro Hardfordiensi et alibi in Angliâ meridionali abundant." Montagu writes: "Doctor Lister says in Hertfordshire, about Ware and Puckeridge." This seems to indicate that Dr. Lister named the localities in some book to which we have not had access. The species is cited for this county by subsequent writers, such as Dr. Jeffreys, R. Tate, etc.

HELIX POMATIA, var. ALBIDA, *Moq.*

Recorded in 1883 as occurring at Puckeridge, Herts, by Loydell and Rowe.

HELIX ASPERSA, *Müll.*

Mr. H. J. J. Lavis found it in 1875 abundant near Otterspool, Berry Wood.

HELIX NEMORALIS, *L.*

In 1875 Mr. Lavis found it abundant near Otterspool, Berry Wood, and in 1883 Messrs. Loydell and Rowe recorded it as occurring at Puckeridge.

HELIX HORTENSIS, *Müll.*

Recorded in 1883 for Puckeridge by Loydell and Rowe.

HELIX ARBUSTORUM, *L.*

Recorded in 1883 for Easneye, by Loydell and Rowe.

HELIX ARBUSTORUM, var. ALPESTRIS, *Ziegl.*

Dr. Jeffreys remarks of this: "Var. 3. Hoddesdon, Herts, on the marshes by the side of the River Lea, the specimens being numerous, and all of the same form and size (Pickering). Such a locality is very remarkable for this dwarf variety, which I have taken on the Swiss Alps, in the region of perpetual snow." In a paper in the 'Annals,' 1877, he remarks on its occurrence in the grounds of Ware Priory as well as on the banks of the Lea. Mr. Taylor in his Life History of the species, repeats the first of these notes.

HELIX CANTIANA, *Mont.*

Montagu, in his Supplement, writes: "We have recently taken it in Hertfordshire." In 1875 Mr. H. J. J. Lavis included this species with a query as abundant "near Otterspool, Berry Wood." And in 1883 the species was recorded by Messrs. Loydell and Rowe as occurring at Puckeridge.

H. SERICEA, *Müll.*

Recorded for Easneye in 1883 by Loydell and Rowe.

VERTIGO MOULINSIANA (*Dupuy*).

It will be sufficient in this case to refer the Hertfordshire conchologists to Mr. Groves' paper in their 'Transactions' (1880) for a copious account of this shell and its occurrence in the county.

V. ANTIVERTIGO (*Drap.*).

Mentioned by Mr. Groves as occurring with *V. Moulinsiana.*

CLAUSILIA RUGOSA (*Drap.*).

Mr. Hopkinson tells us that the shell which Mr. Lavis recorded thus: "*Clausilia,* sp. Berry Wood chalk-pit," was *C. rugosa.*

COCHLICOPA LUBRICA (*Müll.*).

Mr. Hopkinson also says that *C. lubrica* is referred to when Mr. Lavis records: "*Cochlicopa* (Jeffreys), sp. Near Otterspool, Berry Wood."

ACHATINA ACICULA (*Müll.*).

Dr. Jeffreys has the following: "Mr. Pickering informed me that a considerable number of live specimens were once procured by a gentleman in Hertfordshire, while digging up potatoes. His friend, not being a conchologist, thought at first that they were little white maggots." It is added that this species is supposed only to be found on calcareous soils, but that the present and another (a Norfolk) record are evidence to the contrary.*

CYCLOSTOMA ELEGANS (*Müll.*).

From Mr. H. George Fordham's note in the 'Transactions of the Watford Nat. Hist. Soc.,' 1877, on the supposed recent extinction of this species in North Herts, it would appear only to occur in this district in a sub-fossil condition. Mr. Ashford, however, writes to us: "When I was at Hitchin, *Cyclostoma elegans* abounded in the green lanes near Hitchin." Mr. Fordham refers more especially to the neighbourhood of Ashwell.

The list for Hertfordshire appears thus to include the names of 34 species and 7 varieties which have at one time or other been recorded as occurring within the limits of the county, including those which are recorded for the "Lea" and the "New River" without specifying the precise county. We do not vouch for the absolute completeness of the present paper, and will content ourselves by stating that it is the result of a careful search of such works as we have access to, and that for some of the citations we are indebted to our friends Mr. Charles Ashford and Mr. John Hopkinson.

* The greater part of both Hertfordshire and Norfolk being on the Cretaceous formation, I have called Dr. Jeffreys' attention to this remark and he says that he ought to have applied it to Guernsey and other localities where there is no calcareous soil.—ED.

III.

REMARKS ON THE LAND MOLLUSCA, WITH REFERENCE TO THEIR INVESTIGATION IN HERTFORDSHIRE.

By John Hopkinson, F.L.S., F.G.S., F.R.M.S.

Read at St. Albans, 10th January, 1884.

The Land and Fresh-water Mollusca of the British Isles are few in number, comprising only 32 genera and about 130 species; they are widely distributed, for at least half the species may be found almost anywhere within the radius of a few miles; to obtain them is an easy matter, requiring very little apparatus; and as most of them are sufficiently well-represented by their shells, a collection illustrative of these, the testaceous kinds, is easily formed. They are therefore a group peculiarly well suited for study by those who have but little leisure; and I venture to plead for their investigation by members of the Society residing in distant parts of our county, and for aid in a complete search for them in the neighbourhood of Watford. In order to endeavour to awaken an interest in our terrestrial Mollusca I offer the following remarks, leaving the fresh-water forms for the present in the hope that some other member may contribute an introduction to their study.

The British Land Mollusca form the order Pulmonifera (air-breathers)* of the class Gastropoda (belly-footed), and they consist of 83 species which are comprised in 19 genera, these again being grouped into 6 families, as in the following table :—

Arionidæ	*Arion*, Ferussac. *Geomalacus*, Allman.
Limacidæ	*Amalia*, Moquin-Tandon. *Limax*, Linnæus.
Testacellidæ ...	*Testacella*, Cuvier.
Helicidæ	*Succinea*, Draparnaud. *Vitrina*, Draparnaud. *Zonites*, De Montfort. *Helix*, Linnæus. *Bulimus*, Scopoli. *Pupa*, Lamarck. *Vertigo*, Müller. *Balia*, Prideaux. *Clausilia*, Draparnaud. *Cochlicopa*, Ferussac. *Achatina*, Lamarck.
Carychiidæ ...	*Carychium*, Müller.
Cyclostomatidæ ...	*Cyclostoma*, De Montfort. *Acme*, Hartmann.

* Or, with the Limnæidæ which breathe both air and water, the Pulmonobranchiata of Dr. Gwyn Jeffreys and other authorities.

The first three of these families comprise the land mollusks which are popularly known as "slugs," and the last three, those known as "snails," the most evident distinction between the slugs and the snails being that the former do not secrete an external shell into which they can withdraw for protection, while the latter have such a shell into which they can entirely withdraw.

It is in the form, construction, and position of the shell that the distinction between the different families is most readily perceived. In the slugs, the Testacellidæ have a small external shell protecting their most vital organs, the Limacidæ have an internal shell which performs the same function, and the Arionidæ have an internal calcareous plate of indefinite form and loosely-aggregated grains in the same position as the shell of the Limacidæ. In the snails, the Helicidæ secrete a shell, the mouth of which they have as a rule the power of closing by an epiphragm, which they can break up or dissolve at pleasure, and form again when required; while the Cyclostomatidæ close the mouth of their shell when they retreat into it by an operculum as permanently attached to them as their shell, being merely thrown aside, or opened like a lid, when they wish to protrude the anterior portion of their body. The Carychiidæ differ chiefly from the Helicidæ in their tentacles being contractile instead of retractile, and in their eyes being at the base of their developed tentacles instead of at the summit.

It has been objected that too much attention is paid to the shell of the testaceous Mollusca, and that their classification should be based more on their internal organization, but it is self-evident that all differences in the shell must be due to differences in the animal which secretes it and of which it forms an integral part, and that therefore the shell is the outward expression or manifestation of the internal vital organs.

The shell is formed by the "mantle," which is a membranous sac enveloping the greater portion of the body and provided at its open anterior end, forming the "collar," with glands which secrete the shelly matter, and it is to these glands of the collar that the coloured bands and other markings on the shells are due.*

The manner of growth of the shells is peculiar. They remain very small until the animal has become dormant for the first time, after which they rapidly increase in size. Thus some snails hatched in summer increase the size of their shells but little until autumn, when they bury themselves in the ground with their heads upwards, remaining dormant during winter. In spring they re-appear, soon to again bury themselves, but this time with their heads downwards

* I have here adopted the view that the term "mantle" should be applied to this organ in both slugs and snails, that part of it which alone, in the snails, bears colour-secreting glands being differentiated as the "collar"; by some authors, however, this anterior end of the mantle has no distinctive term applied to it, and by others the term "mantle" is confined to the organ in the slugs only, the "collar" being considered to take its place in the snails. A snail strengthens its shell and can repair any part of it by a secretion from the mantle, when the glands of the collar cannot be brought into use, but such new calcareous matter is colourless.

and only for a short time, re-appearing with the shell much increased in size. This process is carried on at intervals during summer, and by autumn the shell is fully grown, the growth having only taken place underground. This method of growth is not however universal, for some species bury themselves in decaying wood, others bury only their heads in the ground, and others again merely hide themselves amongst decaying leaves.

It is not easy to acquire and to retain in the memory a knowledge of any natural objects by reading about them alone, and therefore I would advise those who may wish to study our land Mollusca to commence by searching for them, then to find out their names, and, when these become familiar and are easily remembered, to examine more closely into the external form, internal anatomy, and habits of the various species.

In commencing the study of our land Mollusca in this way the first thing necessary is to know where and when to look for them. An answer is easily given: "Everywhere and at all times." There is scarcely any situation where, at some time or other, they may not be found in more or less abundance. But to know where and when they may be searched for with the greatest chance of success is quite another matter, and necessitates some knowledge of their habits. All more or less affect damp and shady places, hiding themselves from observation in dry or sunny weather, except in the early spring for a short time after they leave their hibernating quarters. The first advice I would give is therefore to "leave no stone unturned." From my own experience of a few months' collecting, at occasional intervals, I believe that there is scarcely a species present in any locality which may not be found under a stone at some time or other. The under side of decaying pieces of wood lying upon the ground, of fallen branches of trees, especially if moss-covered, of fallen leaves, and of the leaves of growing plants, should also be examined; and indeed, except late in the evening, in the night, early in the morning, or soon after rain, the land mollusks will only, as a general rule, be found on "undersides." They cannot bear the heat or the drying power of the sun, nor do they like the glare of full daylight; they love darkness and moisture. This is especially the case with the slugs, and with the snails which have thin or transparent shells. Keep a slug for a short time without access to moisture and it will dry up and die; put a snail with a thin transparent shell in the rays of the sun and it will retreat as far as possible into its shell, and, from loss of moisture, will soon die. Both slugs and snails are constantly, except perhaps when snails are hibernating and in a dormant state, absorbing moisture and excreting it from their bodies as mucus or slime, and wherever they go they leave in their track some of this mucus. Access to moisture is therefore most necessary to the existence of slugs at all times and of snails when in a state of activity. They can exist for some time under water, but in very heavy or prolonged rainfall they will come out of their holes in the ground for fear, it is presumed, of being drowned, and this is the

only thing which will drive some species into the light of day; some will even climb trees on such occasions.

The best time, therefore, to find the land Mollusca in the open country is in the early morning, before the dew of night has evaporated, or, if later in the day, immediately after rain. In woods sunshine is desirable in order the more readily to perceive the minuter forms. But at whatever time and whatever the weather may be, "under-sides" should not be neglected; every thing met with lying upon the ground under which they may be secreted should be turned over and examined; even a heap of stones by the road-side, especially if it has been long undisturbed and contains pieces of limestone or unwaterworn chalk-flints, should not be neglected, and a piece of old matting which has long lain on the ground may prove a fruitful field for research. One thing I think they do not like, and that is leather; I never but once found a slug or a snail under an old boot.

Some species delight in damp moss; these are generally the minuter forms, and therefore the moss requires very careful scrutiny. Moss growing on fallen branches of trees is perhaps a better hunting-ground than moss growing on stones, but damp moss in whatever position, if sheltered from the rays of the sun, may yield a rich harvest. Other species again only occur on vegetation growing on marshy ground.

From the foregoing remarks it may have already been inferred that the terrestrial Mollusca were in all probability originally the denizens only of forests or woods, especially such as are watered by numerous streams or abound in marshy places; and this view seems to be borne out by the habits of the indigenous land mollusks of North America. These are almost exclusively found in dense forests, by the clearing of which they are exterminated, the progress of agriculture and consequent alteration in the natural aspects of the country being so rapid that they have not time to accommodate their habits to these new conditions. In Europe the clearing of forests has been a much slower process, and appears to have given time for some at least of our Mollusca to accommodate themselves to more open situations. It would seem, therefore, that it is in consequence of this adaptability of our species to altered conditions, that several of these which have been introduced accidentally by man to the North American continent have readily become acclimatised, and are taking the place of the indigenous species, supplanting them as surely as the native races of man are being exterminated by those of European origin.*

Hertfordshire is still a well-wooded county, but at one time the greater part of it was probably a dense forest; being also a well-watered county, with not too-rapid rivers, we may presume that formerly both the land and the fresh-water Mollusca found here a most congenial habitat, and with their power of rapid increase would swarm in vast numbers amongst the luxuriant vegetation,

* See Binney's 'Terrestrial Air-breathing Molluscs of the United States . . . .', vol. v, pp. 2, 3.

and find in the chalk, wherever it comes to the surface, and in the water of the numerous streams which rise out of the chalk, calcareous material in plenty with which to form their shells. These conditions still prevail to a great extent, and we may still expect to find in abundance in our woods the species which have not so far changed their habits as to roam about in the open country; a careful search, also, for the species which follow man, frequenting the cellars of houses, the vicinity of cottages where they would thrive on the refuse thrown out, nursery-gardens, and cultivated fields, may also be richly rewarded. There are, on the other hand, some few species which only thrive in proximity to the sea, imbibing moisture from its spray, and which are therefore not likely to be found in Hertfordshire.

It must be evident from what has already been said of the distribution of our terrestrial Mollusca that, as with all other creatures, different species have different habits and frequent different situations. It may be well to enquire a little more closely into this diversity, to have some guide as to where best to look for certain forms, and at the same time to learn something more of the habits of the members of the different families.

The Arionidæ and Limacidæ will be searched for with the greatest chance of success early in the morning from spring to the commencement of winter. Some may be found occasionally on dry exposed ground, but marshy places and moist shady woods are more frequented by them. In mild and humid weather they may be seen on footpaths, under hedge-rows, and on the trunks of trees. In woods they hide in moss growing on the ground, on stones, and on trees, and some may be found under the bark of trees, or wherever there is a crevice into which they can creep, and also under the larger fungi, upon which they sometimes feed; but here, as elsewhere, no stone should be left unturned. All the species are believed to have the power of suspending themselves by a thread of mucus from the branches of trees, but, unlike spiders with their thread, they have not the power of drawing it in, and therefore when once suspended they must reach the ground or something in their way before they can free themselves.

The Testacellidæ are essentially nocturnal animals; they can seldom be found above ground except at night when quite dark, and they are most frequently met with in spring. They are burrowers, and are the only predaceous species amongst the land mollusks. They feed chiefly on earthworms, and are therefore most frequently met with in gardens and highly-cultivated ground, where their prey most abounds. During the day they remain either under the surface of the soil, usually some distance down, or under large stones.

The habits of the Helicidæ are very varied. *Succinea* and *Vitrina* chiefly frequent the margins of streams. The *Succineæ* are in fact almost amphibious; they occur in numbers on plants growing in the water, such as species of *Typha*, *Nuphar*, and *Sparganium*, and may sometimes be found high up on the stems of these plants

and sometimes close to the surface of the water. Towards the end of autumn they have been observed to leave the vicinity of the water and expose themselves to the sun's rays and drying winds, in order, it is supposed, to reduce the bulk of their bodies, which would otherwise be too large to be sufficiently withdrawn into their shells for full protection whilst they are hibernating. Our only species of *Vitrina* (*V. pellucida*) has a body even still larger in proportion to the size of its shell, into which it can barely quite withdraw, but it is nevertheless one of the most hardy of our land mollusks, and almost the only one which roams about in severe winter weather, when it has frequently been observed crawling on the surface of the snow. It is seldom found far from water, and should be searched for in the vicinity of marshes and of running water, and in damp moss in woods as well as in exposed places.

The *Zonites* are most frequently found under stones and pieces of wood which have been lying for a long time on the ground. The species are more difficult to distinguish from each other than those of any other genus, several of them being much alike, and this has led to many erroneous determinations.

The *Helices* are very varied in their habits, and should be searched for in all the situations mentioned as being frequented by the land Mollusca generally. They affect dryer situations than *Succinea* and *Vitrina*, and are not so generally concealed from observation as the *Zonites*. Although the genus *Helix* comprises a large number of species, they are very dissimilar, and consequently easy to identify.

Of the *Bulimi* one species is found almost exclusively near the sea, another buries itself in the earth or amongst decaying leaves, except in wet weather, when it sometimes climbs trees, and the third frequents rather exposed situations.

The *Pupæ* are most frequently found between the stones of loosely-built walls, &c., and amongst moss growing on walls and elsewhere. The species of the genus *Vertigo* differ only from those of *Pupa* in the lower pair of tentacles being absent, and in their shells being smaller, and of course their bodies also; they seem in fact to be miniature, partially-developed, forms of *Pupa*. They inhabit damper situations than the *Pupæ*, and some of the species can only be obtained by wading in streams or marshes and collecting them from the stems of plants which, rising above the surface of the water, afford a habitation for these minute mollusks.

Our only species of *Balia* (*B. perversa*) inhabits moss and lichens on old walls, &c. Of *Clausilia*, *C. rugosa* occurs most frequently in moss growing on trunks of fallen trees and on broken branches, and may also be found amongst almost any heap of stones, especially if containing a few chalk-flints. The other species frequent similar situations, but are not commonly met with.

Of the two British species of *Cochlicopa*, *C. lubrica* attaches itself to the under surface of logs of wood and stones lying on the ground in exposed situations quite as frequently as in woods. The other species, *C. tridens*, occurs sparingly in woods. Our only species of

Achatina (*A. acicula*) burrows in the ground, above the surface of which it is scarcely ever seen.

Of the Carychiidæ there is only one British genus and species amongst the land Mollusca, *Carychium minimum*, and it is the smallest mollusk we possess. It appears to occur only near running water, and it is probably more widely distributed than might be inferred from the recorded localities, for, owing to its minute size, being only $\frac{1}{15}$ of an inch in length and $\frac{1}{30}$ of an inch in breadth, it is very apt to be overlooked.

Of the Cyclostomatidæ the genus *Cyclostoma* has only a single British species, *C. elegans*, which occurs on calcareous soils, and its most usual habitat is under the surface of the soil or amongst decaying leaves at the foot of beech trees. It is not easy to find alive, though its empty shells are frequently met with, and from this circumstance, probably, it has been inferred to be extinct in the northern part of our county.

Our only species of *Acme* (*A. lineata*) occurs under stones and amongst moss in damp places.

To collect our land Mollusca all that is absolutely required are a few small boxes—pill-boxes do very well; it is, however, as well to have a small wide-mouthed glass bottle for slugs, as this will retain the moisture necessary for their existence better than boxes of any kind. I have also found a small brush, such as an ordinary camel-hair pencil, very useful in picking the minuter kinds off stones, leaves, &c., and forceps or a strong needle set in a wooden handle, will sometimes be found of advantage in getting the smaller species out of crevices in stones. On the boxes (and bottles if used) should be written the name of the locality from which the specimens have been obtained and any particulars it may seem advisable to record as to the habitat, the food-plant, &c., of the different species; or the boxes may be numbered and the particulars written against the corresponding number in a note-book.

The mention of food-plants reminds me to draw your attention to the importance of ascertaining, whenever possible, and recording on what the various species feed. Almost all our species being herbivorous, and many of them doing considerable damage to the vegetation on which they feed, it is desirable, not only in order to work out fully the life-histories of the various species, but also for economical considerations, to know what is their favourite food. I have found several species feeding more frequently on the plantain (both *Plantago major* and *lanceolata*) than on other plants associated with it, and therefore have been led to examine its leaves more than those of other plants in searching for the smaller species. Nettles perhaps come next in order, and sometimes after showers they may be found studded all over with different species both large and small.

Very small species should not be put into the same box as the larger ones, so that they may not be lost sight of and may not get damaged; and it is better not to put many of the larger species together into one box, without isolating them in some way, for

they sometimes rasp the epidermis off each other's shells. *Helix aspersa* is a great offender in this way, and I have also found it very active in rasping the inner surface of its box when of cardboard, which all species will do to some extent. After having been shut up for some time the testaceous Mollusca will close the mouth of their shell by an epiphragm or attach themselves to the inner surface of their box, remaining in this state without food for an indefinite period; in fact they have been known to live for many years fastened to a tablet in a cabinet of shells.

The Mollusca collected in a day's excursion or a few hours' ramble may be sent off to the recorder of the Mollusca by post the same evening alive, a little moss or a few leaves in each box containing them being all the packing necessary. A few of the smaller species may be sent in a pill-box enclosed in a letter, but when there are many it is best to send them in several small boxes enclosed in a larger one which should be wrapped in dark-coloured paper and have a luggage-label attached with the address and stamp on, so that the box may not itself be stamped in the post and possibly smashed in the process. If not sent off at once, the animals should be killed, after any desired examination has been made, and their shells kept for the cabinet or sent by post for determination in the same way as with the living specimens. To kill them they should be placed for a short time in a small quantity of cold or lukewarm water, which will induce them to come partly out of their shells, and then boiling water should be suddenly added. It is not a pleasant thing to have to kill any living creature, but when it has to be done as little pain as possible should be inflicted. Therefore the water should be quite boiling, as this only will insure an instant and painless death. Another method of killing them is to place them in methylated spirit, but they must not be left long in it or the epidermis of the shells will be discoloured and perhaps destroyed. It is impossible to take a mollusk out of its shell alive, for there is a muscular attachment between the animal and its shell—between the organised tissues and the exo-skeleton—which is only severed by death. When dead most species can be easily pulled out of their shell with a bent pin; some can only be partially removed; and a few are so minute and in such a fragile shell that their extraction cannot be attempted with safety. Immersion in methylated spirits for a few minutes is said to give increased consistency to their gelatinous bodies, and thus to render them easier of extraction, but I have not tried this. Slugs may be preserved in spirits-of-wine (or methylated spirits) diluted with about one-fifth its bulk of water. The internal shell of the Limacidæ may be obtained by making an incision in the mantle and cutting out the shell.

It is scarcely necessary to give any directions as to arranging shells in the cabinet. They may be mounted on tablets, with several specimens of each species in different positions, so that any part may be examined; or they may be kept in pill-boxes or glass-topped boxes, the smaller species at least being placed on

coloured cotton-wool, which shows them off better than a white ground.

The linear arrangement and naming of the species is the next thing to consider, and I would advise the adoption of the classification and nomenclature followed by our greatest authority on the Mollusca, Dr. Gwyn Jeffreys, F.R.S., in his 'British Conchology' (vol. i, 1862, and vol. v, 1869), with such modifications as recent research and the discovery of new species and varieties necessitate. Rimmer, in his 'Land and Freshwater Shells' (1880), follows Dr. Jeffreys, and the same general classification and sequence of species is followed in the Conchological Society's 'Exchange-list of British Land and Freshwater Mollusca,' published by Messrs. Taylor Bros., Leeds, which is a very useful list for reference; a neatly-printed 'Label-list' is also published by the same firm. These lists enumerate all the species and varieties of the British Land and Fresh-water Mollusca known up to the date of their publication a few months ago. On the labels accompanying the specimens should of course be recorded the locality in which they were found, and it would be advisable to add the habitat or the food-plant. A register may also be kept in which further particulars may be entered.

There are many interesting points in the morphology, anatomy, and physiology of our land Mollusca which there is not time even to allude to. Much might be said about their great tendency to variation, frequent monstrosities, and the variation in band-markings of some species. Their lingual membrane is a wonderful organ, being studded with thousands of minute teeth in rows which they push forward from behind as the first rows become worn, and there is a definite formula for each species, many of which can be identified from a microscopical examination of their jaw. Although their bodies seem to be little more than a mass of jelly almost destitute of muscles and with a very simple organisation, such is not really the case, for their organisation is complex and their muscular strength enormous. Their method of reproduction is very peculiar, and their manner of making love to each other most singular, for they appear then to be engaged in a pitched battle with weapons consisting of calcareous spicules called "love-darts" which they endeavour to strike into any exposed part of each other's bodies.

Lastly, I may mention that their organs of sense are those of touch, taste, smell, vision, and hearing, their sense of taste and of smell appearing to be very slight, and their sense of touch and of vision well developed. Their inferior tentacles are their most sensitive tactile organs, and their eyes, with a few exceptions, are situated at the extremities of their superior tentacles. As they have a heart, consisting of a single auricle, a well-developed system of nervous ganglia, and a large ganglionic mass with which the nerves of their various senses communicate, therefore presumably forming a sentient brain, they probably feel pain and pleasure as we do, though in a less degree.

Appendix.

List of Land Mollusca observed in the neighbourhood of Watford and St. Albans in the autumn of 1883.

The following list is the result of occasional walks last autumn about Watford and St. Albans. To prevent the frequent repetition of the names of these places and of the habitats of the various species, I here enumerate the localities mentioned and give some particulars of those which have yielded the greatest number of species.

In the neighbourhood of Watford, Oxhey Lodge, Watford Heath, Bushey Lodge, Bushey Mill, Otterspool, and Munden Park are in the Colne river-basin. "Near Oxhey Lodge" refers to a small chalk-pit in a wood which I came across after walking through Oxhey Woods and finding only one species, *Helix rotundata*, on the glacial gravel and London Clay on which these woods are situated. "Near Bushey Lodge" refers to a footpath leading from the St. Albans road (opposite Callow Land) to Bushey Lodge, by the side of which under the hedges are here and there heaps of flints which appear to have been taken off the fields, amongst which *Helix hispida* and *Clausilia rugosa* abound. By "Otterspool" a disused chalk-pit in the wood nearly opposite the house is indicated.

Cassiobury Park, Tunnel Woods, and Hunton Bridge are in the Gade river-basin. In Cassiobury Park the woods by the Swiss Cottage have been visited by permission of the Earl of Essex, and a dell which appears to be a disused chalk- and gravel-pit just over the canal-bridge in Rouse Barn Lane, and another above the Navigation Bridge, have been searched; the greater number of species from these dells having been found amongst nettles and under stones, chiefly flints. By "near Hunton Bridge" a steep hedge-bank on the east side of the high road from Watford about half a mile from the village is indicated, and this is the only place where I have yet found *Helix ericetorum*, though it occurs here in abundance.

Most of the species from the neighbourhood of St. Albans were found one evening after rain in the woods and lanes about the Verulam Hills. My only specimen of *Cyclostoma elegans* was found in Gorhambury Park in the course of this walk. The other locality mentioned, "near Park Street," is a dell near the River Ver, just opposite the village, on the road to Hedges Farm. These localities are in the Ver river-basin.

Specimens of various species have been found here and there on hedge-banks, etc., in localities not specially mentioned, but they have mostly been of species too common for any but a general indication of their presence in the neighbourhood to be given.

With the exception of the species of the genera *Arion*, *Amalia*, and *Limax*, all the species enumerated have been kindly identified for me, or my identification has been verified, by Mr. J. W. Taylor, Editor of the 'Journal of Conchology,' who is collecting materials for an exhaustive Monograph of the British Land and Fresh-water Mollusca.

ARIONIDÆ.

Arion ater (L.).*—Frequent in gardens and woods. Var. *rufa* (L.).—In gardens at Watford. Var. *albida*, Roeb.—In gardens at Watford.

A. hortensis, Fer.—Frequent in gardens, &c. In my own garden at Watford this species feeds freely on strawberries.

LIMACIDÆ.

Amalia marginata (Müll.).—Verulam Hills.

Limax flavus, L.—In cellars and about old houses.

L. maximus, L.—In gardens and woods.

L. agrestis, L.—Very common in gardens, meadows, and woods. In my own garden, after heavy rain, this species appears in immense numbers on the lawn, and, like *Arion hortensis*, is very destructive to strawberries.

HELICIDÆ.

Succinea putris (L.).—By the side of the River Gade, Swiss Cottage, Cassiobury Park.

Vitrina pellucida, Müll.—Near Oxhey Lodge; Cassiobury Park; Tunnel Woods; Munden Park.

Zonites cellarius (Müll.).—Common all round Watford, chiefly under flints and other stones; Verulam Hills.

Z. glaber (Stud.).—Near Oxhey Lodge; Swiss Cottage and elsewhere, Cassiobury Park (under stones).

Z. nitidulus (Drap.).—Near Oxhey Lodge; near Bushey Lodge.

Z. purus (Alder).—Near Oxhey Lodge; near Bushey Lodge; Otterspool; Cassiobury Park.

Z. crystallinus (Müll.).—Near Oxhey Lodge; Watford Heath; Swiss Cottage and elsewhere, Cassiobury Park (in moss and under stones and fallen leaves).

Z. fulvus (Müll.).—Near Oxhey Lodge.

Helix aculeata, Müll.—Swiss Cottage, Cassiobury Park (under fallen leaves).

H. aspersa, Müll.—Very common, especially in gardens. In my own garden this species climbs the stem and branches of the broom, in all states of the weather, and towards dusk a considerable number may usually be found attached to several of these shrubs, while not one can be seen on any other tree or shrub.

H. nemoralis, L.—Cassiobury Park and elsewhere in the neighbourhood of Watford. Var. *libellula*, Risso.—Cassiobury Park. Var. *castanea*, Moq.-Tan.—Cassiobury Park. The two varieties occur in the dells mentioned, associated with the type.

H. hortensis, Müll.—Cassiobury Park; near Park Street; Verulam Hills. Var. *lutea*, Moq.-Tan.—Verulam Hills. Var. *incarnata*, Moq.-Tan.—Cassiobury Park; Verulam Hills.

* The authorities within parentheses indicate that the species when first described was placed in a different genus, thus *Arion ater* was described by Linnæus as *Limax ater*, while he described *Limax flavus* under the generic name still applied to it.

H. arbustorum, L.—Swiss Cottage woods and elsewhere, Cassiobury Park; near Park Street; Verulam Hills. Var. *marmorata*, Tayl.—Cassiobury Park; Verulam Hills.

H. Cantiana, Mont.—Near Bushey Lodge; Tunnel Woods; near Park Street; Verulam Hills. Var. *albida*, Tayl.—Near Bushey Lodge; Hunton Bridge; Verulam Hills.

H. rufescens, Penn.—Near Oxhey Lodge; near Bushey Lodge; Cassiobury Park; Tunnel Woods; Hunton Bridge; Park Street. Var. *alba*, Moq.-Tan.—Watford Heath; Tunnel Woods; Hunton Bridge,

H. concinna, Jeffr.—Otterspool; Park Street; Verulam Hills.

H. hispida, L.—Common everywhere about Watford, abounding amongst almost every heap of stones and in nearly every damp sheltered spot.

H. sericea, Müll.—Swiss Cottage woods, Cassiobury Park.

H. virgata, Da Costa.—Gorhambury Park.

H. caperata, Mont.—On hedge-banks near Bushey Lodge; Hunton Bridge (abundant); Park Street.

H. ericetorum, Müll.—Hunton Bridge (abundant).

H. rotundata, Müll.—Common everywhere, in gardens, woods, &c., generally under stones or decaying wood. Var. *rufula*, Moq.-Tan.—In my own garden; Swiss Cottage woods, Cassiobury Park.

H. rupestris, Drap.—Near Bushey Lodge.

H. pulchella, Müll.—Bushey Mill; Navigation Bridge, Cassiobury Park. Var. *costata* is most frequent and ought to be considered the typical form; var. ? *lævigata*, usually considered the type, occurs with *costata*.

Bulimus obscurus (Müll.).—Near Bushey Lodge.

Pupa umbilicata, Drap.—Otterspool.

Vertigo edentula (Drap.)—Swiss Cottage woods, Cassiobury Park.

Clausilia rugosa (Drap.).—Common everywhere about Watford, under stones and in moss and sheltered places; Verulam Hills and elsewhere, St. Albans. Var. *tumidula*, Jeffr.—Near Bushey Lodge; Otterspool; Swiss Cottage woods, Cassiobury Park. Var. *albinos*, Moq.-Tan.—Near Bushey Mill.

Cochlicopa lubrica (Müll.).—Common everywhere round Watford under decaying wood, and frequent under stones.

Carychiidæ.

Carychium minimum, Müll.—Swiss Cottage woods, Cassiobury Park, under leaves, &c., close to the River Gade.

Cyclostomatidæ.

Cyclostoma elegans (Müll.).—Gorhambury Park.

IV.

LIST OF LAND AND FRESH-WATER MOLLUSCA OBSERVED IN HERTFORDSHIRE.

By Ada Selby;
J. Gwyn Jeffreys, LL.D., F.R.S., F.L.S., F.G.S.;
W. S. A. Griffith, F.R.C.S.;
and Alfred T. Brett, M.D.

Compiled by J. Hopkinson, F.L.S.

Read at St. Albans, 10th January, 1884.

The species and varieties of Land and Fresh-water Mollusca in the following list have been collected or observed between Watford and Radlett, and in the beech woods between Aldbury and Ashridge, near Tring, by Miss Selby in 1879 and 1880; in the neighbourhood of Ware by Dr. Gwyn Jeffreys during his residence at Ware Priory from 1870 to 1880; in the neighbourhood of Sandridge near St. Albans by Mr. Griffith in 1875 and 1876; and at Watford, chiefly in the Colne and the ditches and meadows near the river, by Dr. Brett in 1852.

The surnames of the observers are appended to their records, and in the sequence and nomenclature of the species the Conchological Society's 'List of British Land and Fresh-water Mollusca, 1883,' is followed.

CONCHIFERA.

LAMELLIBRANCHIATA.

Sphæriidæ.

Sphærium corneum (L.). — Watford, common; *Selby*; *Brett*. Sandridge, common in every pond; *Griffith*. Ware; *Jeffreys*. Var. *flavescens*, Macg.—Sandridge; *Griffith*.

S. lacustre (Müll.).—Ware; *Jeffreys*.

Pisidium amnicum (Müll.).—Brocket Hall lake, and in River Lea above and below the lake, plentiful; *Griffith*.

P. fontinale (Drap.).—Watford; *Brett*. Brocket Hall lake; *Griffith*. Ware; *Jeffreys*.

P. pusillum (Gmel.).—Watford; *Brett*. Ware; *Jeffreys*.

P. nitidum, Jenyns.—Watford; *Brett*. Ware; *Jeffreys*.

P. roseum, Scholtz.—Ware; *Jeffreys*.

Unionidæ.

Unio pictorum (L.).—Ware; *Jeffreys*. Var. *compressa*, Jeffr.—Ware; *Jeffreys*.

Anodonta cygnea (L.).—Reservoir-stream near Radlett; *Selby*. Watford; *Brett*. Brocket Hall lake, very abundant but not large, the largest specimen measuring 4¼ ins. in length; *Griffith*. Ware; *Jeffreys*.

GASTROPODA.

PECTINIBRANCHIATA.

Paludinidæ.

Bythinia tentaculata (L.).—Watford; *Brett.* Rivers Lea and Ver, in neighbourhood of Sandridge; *Griffith.* Ware; *Jeffreys.*

B. Leachii, Shep.—Ware; *Jeffreys.*

Valvatidæ.

Valvata piscinalis (Müll.).—Watford; *Brett.* River Lea near Sandridge; *Griffith.* Ware; *Jeffreys.*

V. cristata, Müll.—Ware; *Jeffreys.*

PULMONOBRANCHIATA.

Limnæidæ.

Planorbis lineatus, Walker.—Ware; *Jeffreys.*

P. nitidus (Müll.).—Reservoir-stream near Radlett; *Selby.* Watford; *Brett.* Ponds and ditches near River Lea, Sandridge; *Griffith.* Ware; *Jeffreys.*

P. nautileus (L.).—Reservoir-stream near Radlett; *Selby.* Ponds and ditches near River Lea, Sandridge; *Griffith.* Ware; *Jeffreys.*

P. albus, Müll.—Reservoir-stream near Radlett; *Selby.* Watford; *Brett.* Brocket Hall lake; *Griffith.* Ware; *Jeffreys.*

P. spirorbis, Müll.—Near Watford, common; *Selby.* River Lea at Water End; *Griffith.* Ware; *Jeffreys.*

P. vortex (L.).—Near Watford, common; *Selby.* River Lea at Water End; *Griffith.* Ware; *Jeffreys.*

P. complanatus (L.).—Near Watford, common; *Selby*; *Brett.* Ditches near St. Albans; *Griffith.* Ware; *Jeffreys.*

P. corneus (L.).—Ditches of the River Colne between Bushey Mill and Watford; stream near Munden House, Watford; *Selby.* Watford; *Brett.* Ware; *Jeffreys.*

P. contortus (L.).—Watford; *Selby*; *Brett.* Brocket Hall lake; *Griffith.* Ware; *Jeffreys.*

Physa fontinalis (L.).—Ditches of River Colne between Aldenham Abbey and Watford; *Selby.* Watford; *Brett.* Marshy places bordering River Lea, in neighbourhood of Sandridge; *Griffith.* Ware; *Jeffreys.*

Limnæa peregra (Müll.).—Pond near Medburn school, Elstree; *Selby.* Watford; *Brett.* Ponds near Sandridge, common; *Griffith.* Ware; *Jeffreys.* Var. *lacustris* (Leach).—Brocket Hall lake; *Griffith.*

L. auricularia (L.).—Watford; *Brett.* Brocket Hall lake, fairly common; *Griffith.* Ware; *Jeffreys.*

L. stagnalis (L.).—Pond near Medburn school, Elstree; *Selby.* Watford; *Brett.* Brocket Hall lake, and ponds near Sandridge; *Griffith.* Ware; *Jeffreys.*

L. palustris (Müll.).—Watford; *Brett.* Brocket Hall lake, and ponds near Sandridge; *Griffith.* Ware; *Jeffreys.*

L. truncatula (Müll.).—Watford; *Brett.* River Lea at Water End; *Griffith.* Ware; *Jeffreys.*

Ancylus fluviatilis (Müll.).—Ditches of River Colne between Aldenham Abbey and Watford; *Selby*. Watford; *Brett*. River Lea near Sandridge; *Griffith*.

A. lacustris (L.).—Ditches of River Colne near Watford; *Selby*. Ponds near Sandridge, very common.—*Griffith*.

PULMONIFERA.

ARIONIDÆ.

Arion ater (L.).—Ware; *Jeffreys*.

LIMACIDÆ.

Amalia marginata (Müll.).—Ware; *Jeffreys*.
Limax maximus, L.—Ware; *Jeffreys*.
L. agrestis, L.—Ware; *Jeffreys*.
L. lævis, Müll.—Ware; *Jeffreys*.

HELICIDÆ.

Succinea putris (L.).—By the sides of ditches near River Colne between Aldenham Abbey and Watford; *Selby*. Watford; *Brett*. Marshy places bordering River Lea near Sandridge; *Griffith*. Ware; *Jeffreys*.

S. elegans, Risso.—Ware; *Jeffreys*.

Vitrina pellucida, Müll.—Aldenham church-yard; *Selby*. Woods near Sandridge, under moss; *Griffith*. Ware; *Jeffreys*.

Zonites cellarius (Müll.)—Watford; *Brett*. Woods near Sandridge, under moss; *Griffith*. Ware; *Jeffreys*.

Z. glaber (Stud.).—Woods near Sandridge; *Griffith*. Ware; *Jeffreys*.

Z. nitidulus (Drap.).—Watford; *Brett*. Woods near Sandridge; *Griffith*. Ware; *Jeffreys*.

Z. purus (Alder).—Woods near Sandridge; *Griffith*.

Z. radiatulus (Alder).—Ware; *Jeffreys*.

Z. nitidus (Müll.).—Ware; *Jeffreys*.

Z. crystallinus (Müll.).—Aldenham church-yard; *Selby*. Watford; *Brett*. Woods near Sandridge; *Griffith*. Ware; *Jeffreys*.

Z. fulvus (Müll.).—Ware; *Jeffreys*.

Helix aculeata, Müll.—Symond's Hyde, near Sandridge; *Griffith*.

H. pomatia, L.—Near Marford Bridge, Wheathampstead, by the road-side towards Welwyn; *Griffith*. Ware; *Jeffreys*.

H. aspersa, Müll.—Watford; *Brett*. Sandridge, common; *Griffith*. Ware; *Jeffreys*.

H. nemoralis, L.—Sandridge, common; *Griffith*. Ware; *Jeffreys*.

H. hortensis, Müll.—Watford; *Brett*. Sandridge, common; *Griffith*. Ware; *Jeffreys*.

H. arbustorum, L.—Between Sandridge and St. Albans, amongst nettles in the lanes; *Griffith*. Ware; *Jeffreys*. Var. *alpestris*, Ziegl.—Ware; *Jeffreys*.

H. Cantiana, Mont.—Near Watford, common; *Selby*; *Brett*. Sandridge, common; *Griffith*. Ware; *Jeffreys*. Var. *albida*, Tayl.—Sandridge; *Griffith*.

Helix rufescens, Penn.—Watford; *Brett.* Beech woods, Tring; *Selby.* Sandridge, common; *Griffith.* Ware; *Jeffreys.* Var. *alba*, Moq.-Tan.—Sandridge; *Griffith.*

H. concinna, Jeffr.—Chalk-pit near Sandridge; *Griffith.* Ware; *Jeffreys.*

H. hispida, L.—Watford; *Brett.* Sandridge, common; *Griffith.* Ware; *Jeffreys.*

H. sericea, Müll.—Sandridge, on a grassy bank; *Griffith.* Ware; *Jeffreys.*

H. virgata, Da Costa.—Watford; *Brett.* Beech woods, Tring; *Selby.* Sandridge, common, with a brown variety; *Griffith.* Ware; *Jeffreys.*

H. caperata, Mont.—Watford; *Brett.* Beech woods, Tring; *Selby.* Sandridge, on chalky fields; *Griffith.* Ware; *Jeffreys.*

H. ericetorum, Müll.—Beech woods, Tring; *Selby.* Symond's Hyde fields, with a white variety without bands; *Griffith.* Ware; *Jeffreys.*

H. rotundata, Müll.—Near Watford, common; *Selby*; *Brett.* Sandridge, common; *Griffith.* Ware; *Jeffreys.*

H. pulchella, Müll.—Aldenham church-yard; *Selby.* No Man's Land, Sandridge; *Griffith.* Ware; *Jeffreys.*

H. lapicida, L.—Beech woods, Tring; *Selby.* Sandridge, on stumps in hedges; *Griffith.*

Bulimus obscurus (Müll.).—Beech woods, Tring; *Selby.* Sandridge, on tree-trunks and stumps; *Griffith.*

Pupa secale, Drap.—Beech woods, Tring; *Selby.*

P. umbilicata, Drap.—Aldenham church-yard; *Selby.* Watford; *Brett.* Ware; *Jeffreys.*

P. marginata, Drap.—Aldenham church-yard; *Selby.* Ware; *Jeffreys.*

Vertigo pygmæa (Drap.).—Ware; *Jeffreys.*

Clausilia rugosa (Drap.).—Watford, common; *Selby*; *Brett.* Sandridge, common in woods; *Griffith.* Ware; *Jeffreys.*

Cochlicopa tridens (Pult.).—Well Wood, Sandridge, under moss, with a white variety and one in which two of the teeth are united across the mouth of the shell; *Griffith.*

C. lubrica (Müll.).—Watford, common; *Selby*; *Brett.* Sandridge, under moss; *Griffith.* Ware; *Jeffreys.*

Carychiidæ.

Carychium minimum, Müll.—Ware; *Jeffreys.*

Cyclostomatidæ.

Cyclostoma elegans (Müll.).—Beech woods, Tring; *Selby.* By the road-side on the hills between No Man's Land and Wheathampstead—very local and apparently confined to patches of chalky ground only a few yards in extent; *Griffith.* Ware; *Jeffreys.*

V.

NOTES ON BOULDERS AND BOULDER-CLAY IN NORTH HERTFORDSHIRE.

By H. George Fordham, F.G.S.

Read at Watford, 15th January, 1884.

PLATES I and II.

Three years ago I brought before the Society, in a short paper,* the subject of Erratic Blocks or Boulders, and the work being done by a Committee of the British Association in systematically recording the existence and character of these relics of the Glacial Period, and particulars with respect to them. At the same time I appealed to the members of the Society for information and notes respecting the many boulders which are scattered over our county. The subject does not seem, however, to have attracted much attention. Nevertheless I am still not without hope that something may be done in the way of recording facts which may help to elucidate the problem of the Glacial Period as far as Hertfordshire is concerned; and in laying before the Society a few notes on the boulders of my own immediate neighbourhood, I may perhaps suggest to other members the possibility of their doing a similar work in their own districts. Lest it should be thought that nothing short of detailed and elaborate information is valuable, I would at once say that any notes, however brief, if only of those boulders which, from lying in prominent positions in public places, come under the daily observation of the passers-by, will be very gladly received. The Erratic Block Committee of the British Association has now made eleven Annual Reports, in which are recorded many hundreds of boulders from all parts of England, as well as from Wales, but much remains to be done, and from day to day the destruction of boulders makes the accomplishment of the work more and more difficult. The more fully the matter is gone into, the more apparent becomes the importance and magnitude of the inquiry, and as the Committee are anxious not to attempt to deal, in any summary or analysis, with the results obtained, before there is material at their disposal which may enable them to make such a summary fairly complete for the area to which it relates, they naturally look for local assistance to those parts of the country from which they have at present little or no information. In Hertfordshire but little has been done, while there is undoubtedly much work which should be done, and which must be done before we can regard the county in this matter as anything but a *terra incognita*.

The ultimate practical object of the British Association Committee is the preparation of a map showing on a sufficiently large

* "On the Importance of Recording Erratic Blocks," 'Trans. Herts. Nat. Hist. Soc.,' Vol. I, p. 163.

scale the distribution of the various rocks and classes of rocks which occur as boulders over the whole country. On such a map of boulders can be laid down, with more or less probability, the localities from which the various rocks have been derived and the courses the boulders have travelled from these localities to the places in which they are now found, and the general distribution of ice-borne rocks would then be seen at a glance.

As a part of the most southern area over which this general distribution of boulders extends in England, Hertfordshire has some special interest, and although our erratics are not of such striking dimensions, or perhaps of such interesting materials as are some of those found farther north, they yet help to tell a story of much importance, and a knowledge of their characteristics will contribute towards clearing up the history of a period which, although very remote in point of time, has a distinct and tangible connection with the history of man, and the study of the present climatic condition of the earth.

To note and record all the boulders now existing on the surface in Hertfordshire would involve a survey of the whole county. This can hardly be attempted by any one person; but if some one could be found in each parish in the county who would for that parish note the boulders within its boundaries, the work would soon be done. It is convenient that it should be done with relation to small areas, such as that of a parish. Negative as well as positive information is valuable. To know that boulders are absent from any parish or district so far removes our ignorance. Partly in order to show what may be done, and partly with a view of recording within the county what has already in the main been incorporated in the Reports of the Erratic Block Committee of the British Association, I now bring before the Society notes on the boulder-clays and boulders of the Parish of Ashwell, and of several other parishes and places in the north of Hertfordshire.

The area I shall refer to lies in that district of the county bordering on Cambridgeshire and Bedfordshire which is north of the main ridge of the Chalk outcrop. Some short description of the superficial characteristics of the district, and of the position and character of the beds from which the boulders are derived, and their relation to the superficial geology and physical geography, are necessary in order that the present position of the boulder-clays and gravels and their connection with the changes which have taken place in the local configuration of the surface may be clear.

In the map showing the river-basins of Hertfordshire in Vol. I, part 3, of our 'Transactions' (facing p. 127), a line running through Therfield and Stevenage, nearly S.W. and N.E., marks the water-parting between the streams draining into the Thames and those draining into the Ouse, and at the same time divides the country on the south, which is pretty-generally covered with boulder-clay or gravel, from the band of bare chalk, diversified with occasional patches of boulder-clay, with which I am specially concerned in this paper.

The ridge upon which this line runs is of considerable elevation, rising, at its highest point, at Therfield, to 550ft. above sea-level.

Standing on this ridge at Kelshall (about a mile W. of Therfield), and looking to the N. and N.W. into Cambridgeshire and Bedfordshire, the ground from one's feet falls rapidly away over the outcrop of the various lower beds of the Chalk for about four miles, until, at the bottom of the shallow valley, a line of springs is reached, brought out by the Totternhoe stone, at an elevation above the sea of about 150ft. The average slope, therefore, of this side of the valley is about 100ft. per mile. The slope is, of course, very irregular and diversified by hills and valleys and transverse ridges, of which latter, one more marked than the rest, capped towards its northern termination by a bed of boulder-clay, divides the head-waters of the Cam or Rhee at Ashwell from the streams which run to the Ivel more to the west. This ridge joins the main ridge at Kelshall. A similar transverse ridge, but very ill-defined for a considerable distance from the main ridge, runs down from Wallington to Bygrave, where it forms a considerable hill, also capped with clay. Generally in this narrow strip of Chalk country there is no surface-drainage, the exception being where patches of boulder-clay throw off the water; all the valleys, and the lower and some of the higher hills, are bare chalk. Patches of clay and gravel lie here and there on the higher hills. There are, however, occasionally, crossing this band of bare chalk, water-courses, which, under ordinary circumstances, are dry ditches, but which fill with water after heavy rain. These water-courses drain off the patches of clay, and especially the small area of clay, perhaps consisting of washings from the clay originally capping the hills, which lies along the highest ridge just within the limit formed by the water-parting, that is to say within the valleys of the Cam and Ivel. These ditches draining into the Cam and Ivel bring down at times of heavy rain a good deal of water. There are thus two sources of river-supply; the permanent flow from the springs brought out by the impervious bed of the Totternhoe stone at its outcrop, which contribute the main volume of water to the streams, and the occasional flow of surface-water from the boulder-clay, which, after passing over a strip of bare chalk, finds its way into these same streams.

One of the conspicuous features of this district is the position of the boulder-clays and gravels capping the hills, the valleys between these hills being free from clays or gravels, except such trifling deposits as are clearly due to the intermittent streams which pass through them. It is also to be observed that it is only on the higher hills that the clays lie; and that the summits of these clay-capped hills lie in the plane of one general slope from the main ridge of the water-parting between the Thames and Ouse valleys. This plane seems to represent in a general way the surface of the country at the time of the deposition of the glacial beds, which were, no doubt, spread pretty uniformly over the whole district. The clean-cut valleys which we now have, probably represent in

direction, *but not in depth or extent*, the valleys of the Glacial Period; but it seems clear that there has been a considerable amount of denudation since that period, and that not only have the clays been washed away from a large portion of the face of the country, but also that the valleys have been greatly deepened. If this were not so, we should find here and there traces and patches of clay low down in, and probably even at the bottom of, some of the valleys. In some places, no doubt, there is a sort of washing of clay in the valleys; but it appears to have resulted from the washing down of the clay which lies on the tops of adjacent hills. The chalk hills, where free from boulder-clay, have a very slight subsoil; in the area of the outcrop of the chalk-with-flints this is a dark mould with flints; on the lower beds the subsoil is marly.*

It should also be noted that where patches of gravel and clay lie on the tops of the hills, they are generally found in slight depressions of the chalk; perhaps their preservation is partly due to this fact, although it may be that these depressions have been formed by the decay of the underlying chalk and the consequent letting down of the superincumbent clays and gravels subsequently to the period at which they were originally deposited.

On referring to Mr. Elsden's map at p. 151 of Vol. II of our 'Transactions,' it will be seen that there are marked upon it two considerable outlying patches of boulder-clay on the N.W. side of the railway between Baldock and Royston. It is from the smaller and more northerly of these two patches that the boulders now lying in and near the village of Ashwell have been obtained. This patch lies on a hill which forms the prominent terminal mass of one of the transverse ridges I have already referred to. This hill, known as Clay Bush Hill, is at its highest point 329 feet above sea-level. No doubt a considerable quantity of gravel has been obtained from it. When roads were made and mended exclusively with local materials, the glacial gravels in this district were largely drawn upon for road-metal; and in the course of digging for gravel, when

* A small pit (B on map) cut in the slope of a hill, on a by-road on the south side of and a quarter of a mile from the main road from Baldock to Royston, in the parish of Therfield, shows:—(1) Blackish sub-soil full of angular fragments of chalk with a few flints, a few inches to three feet in thickness; (2) Chalk, a good deal broken, containing many broken *Inocerami*, generally small (? *mytiloides*), and occasionally a small round or finger-shaped flint. Towards the north end of the pit a sand-pipe is shown, containing fine, red and yellowish loam. There are traces also of ferruginous matter in cracks in other parts of the section. There is, however, no trace of loam in the subsoil, which lies directly on the chalk and cuts across the top of the sand-pipe. On the hill above, angular fragments of flint are numerous, and amongst them are large flints almost unbroken. A shallow pit (A on map) about half a mile north-west of this section, and on a lower bed of the chalk, just north of the railway, gives a section three to four feet deep, in the bottom of a shallow valley, as follows:—(1) subsoil, eight inches to one foot; (2) yellowish marl, containing small fragments of angular blue and white flints, and much small chalk rubble, varying in thickness up to one foot two inches; (3) a similar bed to 2, but with much flint (about one-third of the bed), in angular pieces (none worn), of varying size up to six inches and eight inches in longest diameter, and with here and there a small boulder-clay pebble, about one foot in thickness.

boulders were met with, they seem generally to have been carted into the villages for use in paving and building and as blocks at the corners of buildings. There is only one small pit now open on Clay Bush Hill. The section is very irregular and presents no features of interest, but it may be worth recording, if only to give a general idea of the miscellaneous character of the deposit. The following are my notes of the section marked C on the map. Three sections in various parts of the pit are given.

I.	1. Clayey subsoil, with a few angular flints	1ft. 6ins.
	2. Gravel of chalk-pebbles, angular flints, and sand	0ft. to 2ft.
	3. Fine, stratified, brown sand, with beds of small pebbles	0ft. to 4ft.
	4. Gravel of chalk-pebbles, angular and iron-stained flints, ferruginous nodules, and fragments of derived rocks (boulders).	
II.	1. Subsoil.	
	2. Blue, chalky, boulder-clay	3ft. to 4ft.
	3. Fine sand.	
III.	1. Subsoil.	
	2. Clay	1ft. 6ins.
	3. Sand	1ft.
	4. Gravel.....	8ft.

Where this patch of clay and gravel is cut by the railway at its southern end, the section is now too much obscured by the slipping down of the clay to give much information. It shows, however, that the clay lies in a depression or trough in the chalk, being perhaps 20ft. thick in the centre of the depression, and that it has at its base an irregular bed of conglomerate or breccia consisting of flints, mostly iron-stained and sub-angular, in a dark matrix.

In a small outlier from, and to the N.E. of, the main mass, also in a depression in the chalk of some depth, but which is an exception to the general rule, and lies on a hill somewhat lower than adjacent hills which themselves are bare of clay, large excavations for clay and gravel have been made at different times. Here a bed of dark bluish clay, with chalk-pebbles, large septariæ, and *Ostreæ* and *Belemnites* from the Oolites and the Lias clays, rests on miscellaneous beds of sub-angular flints, and gravels, and sands of various textures. In these gravels large *Belemnites*, and specimens of *Gryphæa arcuata*, are not uncommon, and in the fine sands small fossils from the Chalk occur (principally spines of *Echini* and specimens of *Terebratulina gracilis*).

In the ninth Report of the British Association Committee* I have given a list of nearly two hundred boulders and pebbles from Clay Bush Hill now lying in Ashwell. The notes in this paper will necessarily be founded upon this list. The particulars given in the list are very brief, and I propose now to supplement them by an analysis and summary of what may be arrived at by an examination of the materials of the boulders, and their size and superficial characteristics.

In the first place I give a list of the larger specimens, selecting

* 'Report of the British Association, 1881,' pp. 207-217.

for my purpose all the boulders which are in one dimension at least two feet and upwards. Of these I find there are sixteen. (See List I, p. 43.) All these larger boulders (except Nos. 143 and 150*) are worn and rounded, and have evidently been subjected to great wear and tear. The two boulders excepted have *possibly* been brought from Stotfold, some miles west of Ashwell. As to materials we find that the rock in most cases is a sandstone or grit, either of doubtful origin, or, in two cases at all events, almost certainly derived from the Millstone Grit. One specimen is dolerite; one appears to be part of a septaria, possibly from the Kimmeridge or Oxford Clay; one is a limestone, which is probably from the Oolitic series; and the specimens of doubtful origin (Nos. 143 and 150) are a limestone and a schist.

Considering these larger boulders alone, one is at once struck by the preponderance of sandstone, and it will be found that this material in various forms is by far the most common rock in our boulders of all sizes.

On looking at the complete list of boulders and pebbles from Ashwell one notices the want of variety in the description of the materials, and, apart from the larger boulders I have enumerated, in the size and character of the specimens. It is certainly the case that a large number of what may be called duplicates have been catalogued; but although this does in some respects cumber the ground, there is this point to be regarded, that in breaking ground in a new district, and before the characteristics of the boulders of such a district are thoroughly understood, it is desirable to make, in the first place, a more exhaustive enquiry than is necessary where the ground is better known.

With this in view I have endeavoured to catalogue rather too many than too few, to bring together duplicates rather than omit any specimen of possible interest. There is also an advantage in this course. The collection of specimens of the boulder-rocks from Ashwell being as nearly as possible exhaustive, is roughly illustrative of the proportions of the different materials present as boulders. To bring out clearly these proportions I have made a rough analysis of the materials; and, excluding a certain group (Nos. 126 to 155, marked in the lists with an asterisk) which contains a few boulders at all events which *may* have come from Stotfold, and five others which may possibly not be boulders at all, I have a total of 154 remaining. Of these no less than 116, or about 75 per cent., are sandstones and grits; 13 only are limestones, and there are two specimens of septaria, in all 131, or 85 per cent. of sedimentary rocks. Of basalts † there are 19, and of granites, 4; making 23, or 15 per cent. of igneous rocks.

* The numbers used throughout the lists are those used to distinguish the specimens of the rocks in my collection, and are used in the lists as printed in the British Association Reports, from which also the descriptions in the lists as now printed are taken.

† I use the term basalt in a general sense. Mr. Elsden, in his paper (see p. 47), goes minutely into the characteristic features of the materials of these boulders, and to his descriptions reference should be made.

These percentages are borne out by common observation. In walking in the streets of Ashwell one sees everywhere sandstone pebbles in the pavements of yards, sandstone boulders at the corners of houses, and only here and there a limestone, and occasionally a basalt or other igneous rock. The sandstones are superficially, as seen in worn boulders and pebbles, much alike, but when broken a good deal of variety is disclosed. I have selected 37 specimens as representative of all the varieties we have of this class of materials. (See List II, p. 44.) It will be noticed that no attempt is made in most cases to express anything more than a doubtful opinion as to the beds from which these rocks are derived. In some cases specimens from the Millstone Grit series are identified; but in general, of hand specimens of such sedimentary rocks as we have, nothing very definite can be said. That many of our sandstone boulders come from the Carboniferous rocks seems probable, but there are also, no doubt, many from the Secondary rocks of the Midland Counties; it is impossible in many cases to separate with any certainty the one from the other. Of the numerous pebbles too small to note, which are found composing the pavements in Ashwell and the neighbourhood, nearly all are compact, fine-grained, yellowish or reddish sandstone. The limestones, being few, I have thrown into one complete list of 26 specimens. (See List III, p. 45.) They are generally from the Carboniferous Series, the Lias Marlstone, or the Oolite; derivations which agree with and support those assigned to the sandstones. Of the basalts only one is among the group of larger boulders (No. 103, in List I), but three others may be mentioned as of respectable dimensions; and the remaining four specimens of igneous rocks are noteworthy. (See List IV, p. 46.)* No doubt these boulders have come from a more distant source than the sedimentary rocks which form the mass of the boulders at Ashwell.

The large patch of boulder-clay which covers the top of the hill, upon which stand the church and the few houses and buildings which form the village of Bygrave, is similar in character to that on Clay Bush Hill. This is the larger of the two patches marked on Mr. Elsden's map. The summit of the hill is of almost exactly the same elevation above sea-level as that of Clay Bush Hill, a "bench-mark" on the church being 314 feet above sea-level. A very indifferent section in a gravel pit on the north of Bygrave shows a clay, with gravel and sand similar to that on the opposite hill.

I have not made any systematic search for boulders here. One large specimen is worth noting, however. It is of a yellowish, compact sandstone, lies near the church, by the road-side on the summit of the hill, and measures about 3 feet by 2 feet by 2 feet.

Between these two hills is a valley, which at its lowest point on the section is 198ft. above sea-level, and therefore about 130 feet below the summits of the boulder-clay-capped hills on either side.

* For further particulars of the igneous rocks from this district see Mr. Elsden's paper already referred to.

I notice the condition of this valley in order to enforce my general conclusions as to the washing-out and deepening of the valleys of this district, which I assume to have taken place since the deposition of the boulder-clays.

The ditch which runs along the bottom of this valley drains off the boulder-clays on the main ridge of the chalk hills between Kelshall and Wallington. At several points in its course there are shallow workings for gravel and flints adjoining its present banks. One of these workings, in the parish of Sandon, gives the following section (marked D on the map).

1. Subsoil—dark, chocolate-coloured clay, with rolled pebbles and angular flints .... 1ft.
2. Rubble—almost exclusively chalk-pebbles in a slightly sandy or chalky matrix, with many broken, angular white and blue flints, and a few small boulder-clay pebbles. But few whole flints .... 2ft.

There is generally a vein of light brown sandy chalk rubble at the top. In many places the gravel consists almost entirely of fragmentary flints. A few sandstone boulders, one 1ft. by 3in. by 1¾in., and others smaller, have been exposed. The base of the pit consists of very irregular, hard, consolidated rubble.

Similar workings in the valley between Clay Bush Hill and Bygrave give a very similar section (marked E on the map). My notes are as follows:—

1. Grey, marly subsoil .... 1ft. to 2ft.
2. Chalky rubble, with sandy veins * .... 5ft. 6ins.

Another section at the same point gives:

1. Subsoil with a clayey band at bottom .... 3ft.
2. Sandy bed.

The bottom of these pits is generally very uneven. The following larger fragments have been noted:—

1. Hard, dark block of (?) quartz or hard limestone, of irregular shape, rounded, and with smoothed surface 15ins. by 11½ins. by 8ins.
2. Sandstone slab .... 13ins. by 8½ins. by 2ins.
3. Slab of white sandstone, angles very slightly rounded (one end broken off) .... 16ins. by 14ins. by 2½ins.

* At one point this bed is divisible as follows:—Sandy rubble for about a foot at top; then whitish chalk-rubble, the only distinction between these two being the addition of a little reddish sand to the upper bed. The materials of these beds consist of about one-half sub-angular and rounded, white, chalk-flints; the rest sandy particles, small rolled chalk-pebbles (abundant), about the size of larks' eggs, and small fragments of flints.

Since this paper was written the remains of a horse have been exposed in this section at the depth of a little more than four feet, in undisturbed gravel. The section shows, (1) Subsoil 1¼ft., (2) Chalk rubble and flints 3¼ft., and (3) an irregular band of greyish marl, in some places a foot thick; its limits are defined here and there by a thin ferruginous band, and in some parts it is marked with dark stains. The whole length of this band of marl is 6½ft. At one end fragments of bones from the jaw and head, and teeth are exposed. Below to the bottom of the section there is (4) about 1½ft. of rubble.

A few brown, rolled gravel-flint pebbles, the largest 2ins. to 3ins. long, but generally smaller, also occur.

A small section near Newnham (marked F on the map) shows:—

1. Marly subsoil	2ft.
2. Yellow, sandy rubble, with angular and broken flints and small chalk pebbles.	

These three sections seem to indicate that after the removal of the boulder-clay from the valley in which they are found, and after the subsequent denudation of the valley until it attained its present depth, the first deposit brought down, perhaps partly by the stream running intermittently along it, and partly derived from the sub-aerial denudation of the slopes of the adjacent hills, was the bottom and principal bed in the sections, composed almost entirely of white chalk fragments, and of pebbles and flints derived directly from the chalk; indicating that the valley and adjacent slopes were free from clay and presented to denuding agents nothing but bare chalk.

Above this we find in each place a subsoil, in the first case coloured by the brown clay which has given distinctive colouring to much of the country which lies near the now existing boulder-clay patches, and which I attribute to the gradual washing down from these patches of small quantities of the clay, and in the others white and marly where the immediately overhanging hill is now white and bare.

As far as the purely local evidence goes I think that it supports my conclusions as to the course and character of events, and the changes in the configuration of the particular and limited district from which the evidence is derived. I do not pretend to carry the matter further, or attempt to bring into harmony with, or indicate the differences which may exist between, theories of the course of events as applied to more extended areas.

I now proceed to note briefly a few other boulders in this part of the county.

The large boulder at Royston has been fully described in our 'Transactions.'* Two smaller boulders at Royston are noted in the fifth Report of the British Association Committee.† One of millstone-grit, 3ft. by 2ft. by 1ft., and a smaller sandstone boulder, were then lying in the garden of a house in Melbourn Street.

Two boulders at Kelshall on the main ridge at a point at least 500ft. above sea-level are referred to in the eleventh Report of the Committee.‡ These are of special interest as showing that the larger boulders and those which have probably come from as distant a source as any in the district occur at the highest points reached by the hills of the district. There are other boulders in the village of Kelshall and in the neighbouring villages on the ridge. I quote from the Report:—"The following boulders, when they were examined in

* 'Trans. Watford Nat. Hist. Soc.,' Vol. II, p. 249.
† 'Report of the Brit. Assoc., 1877,' p. 84.
‡ 'Report of the Brit. Assoc., 1883,' p. 143.

September, 1880, were lying together in a grass field, near the end of a cart-shed, on the north side of the road leading into the village from the west, and about 100 yards north of the church, upon the ridge already referred to, just on the dividing line or water-parting between the Thames and Rhee. (1) Smoothed, with five flat, or nearly flat facets on the top and sides as it now stands. Mr. J. Vincent Elsden, F.C.S., describes the material from a small specimen as 'Very much decomposed throughout. The interior shows traces of an original dark crystalline rock, containing much magnetite which has weathered reddish brown. Felspar crystals (probably plagioclase) are distinguishable. Probably dolerite.' 3ft. 4in. by 2ft. 9in. by 2ft. (2) Roughly rhomboidal, much worn, and the upper surfaces, and to some extent the sides, furrowed by atmospheric action. Compact limestone : mountain limestone. 2ft. 7in. by 2ft. 6in. by 2ft."

In the same report I describe a number of boulders at Hitchin.* It will be convenient not to extend this paper by reproducing any detailed description of these boulders, especially as they represent only a small part of those lying at Hitchin which are worthy of note. It will be as well, however, to mention that they are of similar materials to those found at Ashwell; the largest specimens being in this case of Mesozoic rocks—one (1) 5ft. by 2ft. 5in. by 2ft. is almost certainly Lias marlstone; others (5) 4ft. by 2ft. by 1ft. 10in., (9) 5ft. 2in. by 3ft. 2½in. by 2ft. 6in., and (10) 2ft. 4in. by 1ft. 8in. by 1ft. 5in. appear to be derived from the same bed or from the Inferior Oolite, and one or two others can be identified as Lias.

Mr. Marlborough R. Pryor, of Weston Manor, Stevenage, sends me the following particulars of boulders at Weston. "The largest boulder in Weston was found by me in a field called Church Close, near the back of the Wesleyan Chapel, at a depth of about 6 feet, in boulder-clay about 30 feet at least in thickness. It appears to be diorite. It fell into several pieces on being touched, and may now be seen where it was lifted out. In its original position, nearly 6 feet below the surface, it would be about 460 to 470 feet above sea-level. It measured about 3ft. 9in. by 3ft. 6in. by 2ft. 3in. Other considerable boulders are mostly quartzites; some are of plumpudding-stone. Boulders weighing 30 to 100 lbs., of septarian nodules, mountain limestone, and chalk, are common (the latter very), and show ice-scratchings almost always. The principal sources of the boulder-clay seem to have been the Kimmeridge and Oxford Clays, and the Chalk; but the plum-pudding-stone and pebble-bed stuff are noticeable as presumably coming from the south."

Boulders at Westmill, near Buntingford, have been recorded by Mr. R. P. Greg. They are all small, and of Mountain Limestone.† Mr. Greg also notices a small boulder, apparently of Millstone-grit, and specimens of the common, fine-grained, compact sandstone,

* 'Report Brit. Assoc., 1883,' pp. 144-146.

† "Third Report of the Erratic Block Committee." 'Report of the Brit. Assoc., 1875,' p. 86.

in the same neighbourhood, and larger boulders of plumpudding-stone.*

Although not within the county, an unusually large and important boulder which stands on the side of the high road near Newport, in Essex, is sufficiently near the borders of the county to be legitimately referred to in this paper. The information I am now able to give with respect to it is supplied to me by Mr. George F. Linney, of Saffron Walden. He writes as follows:—"The boulder stands by the road-side on the high-road from Cambridge to Bishop's Stortford, and may be dotted on the Ordnance map as 225 yards south of the entrance to the Short-grove demesne on the side nearest to Newport. It is about a mile from Audley End Station. Dimensions (above ground):—Height, 6 feet. Width at top, 3ft. 6in.; at bottom, 6 feet. Thickness, 2 feet. General shape regular. The top leans a little southward. Sides nearly flat, and bearing marks of laminæ. I easily cut small pieces, the way of the strata, but the main body of the stone is very hard. Near the top on the south side a large piece of iron has been driven in very deeply, and bears marks of having been heavily struck with a hammer. The country people tell us that 'the stone grows slowly round this iron, and will soon cover it entirely!' In the neighbourhood of Arkesden there is another boulder smaller than this, and composed of the Hertfordshire conglomerate. Of this same material are some in the garden of Mr. Edward Gibson, taken there many years ago by his father. They now form a rockery. Mr. Joshua Clarke also has some, which are conglomerates too, and have been got in the neighbourhood. The Newport one is unique in the neighbourhood. I can only hazard an opinion that it looks to me much like Millstone-grit, such as I have been accustomed to see in Yorkshire and Derbyshire."

In reply to an enquiry as to the existence of any local history or tradition attaching to the Newport boulder, Mr. Linney also writes: "I have made all enquiry from those who are likeliest to know, and have sought the histories of local interest through. I cannot learn anything of the boulder at Newport. There seems to be an opinion in the minds of some that it was put there as a mark for the Lepers' Hospital, which was done away with by Henry the Eighth." The height of the boulder above sea-level is about 180 feet.

LIST I.

Boulders of more than 2 feet in one dimension.

64. Rounded and much worn, without any particular regularity of shape. When moved, the lower portion of the surface, where it had not been exposed, was much less worn, and rather uneven. *Sandstone*: corresponds in character with hand-specimens of *Millstone-grit*. 2ft. 10in. by 2ft. 8in. by 2ft. 0in.

68. Worn and smoothed slab, showing lines of bedding, and weathering iron-red. Coarse, deep red, ferruginous *sandstone*, with rounded grains: *Neocomian*. 2ft. 0in. by 2ft. 0in. by 1ft. 0in.

* 'Trans. Watford Nat. Hist. Soc.,' Vol. I, p. 172.

69. Irregularly-shaped, angles well rounded, and sides smoothed. Top much worn by use as a stepping-stone. Hard ferruginous *sandstone*, weathering red. 2ft. 4in by 1ft. 10in. by 1ft. 5in.
70. Irregularly-shaped, worn and smoothed. Coarse, rather ferruginous *sandstone*. 2ft. 1in. by 1ft. 5in. by 1ft. 4in.
71. Flat, roughly hexagonal slab, top quite smooth and flat, sides and angles worn. Compact, light-yellow *sandstone*. 2ft. 6in. by 1ft. 11in. by 1ft. 0in.
74. Long, flattish, worn, and smoothed. Hard, fine *sandstone*: *Carboniferous* or *Oolite*. 2ft. 6in. by 1ft. 6in by ?
103. Smoothed, rounded, faces nearly flat. *Dolerite*. 2ft. 6in. by 1ft. 8in. by 1ft. 6in.
104. Flat, roughly-triangular slab, edges rounded, upper surface broken. Fossiliferous *limestone*: probably *Oolite*. 2ft. 2in. by 2ft. 0in. by 9in.
105. Long block, irregular shape, much worn, and angles rounded. Coarse *grit*: probably *Millstone-grit*. 2ft. 5in. by 1ft. 8in. by 11in.
108. Rounded, flattish oval. Part of *septaria*: possibly from *Oxford* or *Kimmeridge clay*. 2ft. 0in. by 1ft. 4in. by ?
114. Flat slab, surface well smoothed, and angles rounded. Very hard, fine, ferruginous *sandstone*: possibly *Carboniferous*. 3ft. 0in. by 2ft. 0in. by 6in.
116. Worn, rounded, flattish block. *Sandstone*: possibly *Oolitic*. 2ft. 1½in. by 1ft. 5in by 1ft. 1in.
118. Slightly rounded, triangular block, sides flat and smooth. *Sandstone*: probably *Oolitic*. 2ft. 1in. by 1ft. 7in. by 1ft. 0in.
*143. Rough, angular slab (possibly not a boulder). *Limestone*, with fossils: probably *Mesozoic*. 2ft. 6in. (?) by 8in. by ?
*150. Rough, flat-topped slab, worn on lower side, appears to have been broken on upper face. *Schist*. 2ft. 0in. by 1ft. 2in. (?) by 7½in.
188. Worn and smoothed. Fine *sandstone*: possibly *Jurassic*. 2ft. 0in. by 1ft. 3½in. by ?

LIST II.

Sandstone and Grits.

7. Very irregular in shape, smoothed, rounded, and marked with lines of bedding. Ferruginous *sandstone*: *Oolite* or *Neocomian*. 17in. by 13½in. by 8in.
10. Roughly prismatic, irregular surface, slightly worn. Fine, ferruginous *sandstone*: *Inferior Oolite* or *Neocomian*. 12in. by 7in. by 6in.
16. Roughly prismatic, irregular surface, rounded. Ferruginous *sandstone*: *Oolite* or *Neocomian*. 15in. by 10in. by 8in.
22. Roughly rectangular, with uneven, smoothed upper surface. *Sandstone*, with carbonaceous markings. 11in. by 7½in. by ?
40. Upper surface flat, otherwise rounded. Coarse *sandstone*: rather like *Millstone-grit*. 11½in. by 11in. by ?
47. Long, sub-angular, stratified slab. Ferruginous *sandstone*: probably *Oolite*. 19in. by 5½in. by ?
48. Rectangular, sides flat, angles but little worn. Fine, ferruginous *sandstone*: probably *Neocomian*. 12in. by 5in. by ?
52. Flattish, smoothed, worn; surface irregular. *Sandstone*: probably *Jurassic*. 8in. by 9in. by 5in.
57. Sub-angular, worn. Ferruginous, calcareous *sandstone*: *Neocomian* or *Oolite*. 11in. by 6in. by ?
62. One end broken, otherwise much rounded and smoothed. Coarse *sandstone* or *grit*. 15in. by 11in. by 6in.
64, 68, 69, 70, 71, 74. (See List I.)
76. Much rounded, nearly oval in shape. Coarse *grit*: probably *Neocomian*. 8in. by 7½in. by 5in.
80. Wedge-shaped, with flat, smoothed faces, and rounded angles. Fine *sandstone*: probably *Oolitic*. 8in. by 7in. by 5in.

88. Much worn and smoothed. Ferruginous *grit*: probably *Neocomian*. 20in. by 14in. by 7in.
98. Smoothed and rounded slab. Hard *sandstone*: *Carboniferous* or *Oolite*. 9in. by 6½in. by 3½in.
105. (See List I.)
110. Rounded, smoothed, slightly cuboidal in shape, angles well worn. *Sandstone*: probably *Millstone-grit*. 12in. by 11in. by ?
112. Rounded, cuboidal. *Sandstone*: probably *Millstone-grit*. 12in. by 11in. by 10in.
114, 116, 118. (See List I.)
*130. Angular block, very little worn. Coarse *sandstone*: probably *Millstone-grit*. 17in. by 12in. by 7in. (?)
*131. Roughly rectangular, surface uneven and broken, but somewhat worn. Hard *sandstone*, with plant remains (?): probably *Jurassic*. 14in. by 11in. by ?
*133. Rounded, worn, flattish fragment. Ferruginous, slightly calcareous *sandstone*: probably *Neocomian*. 10in. by 8½in. by 3in.
*138. Rough, broken, somewhat smoothed on one side. Coarse *grit*, with small, rounded quartz pebbles: *Millstone-grit*. 6½in. by 6in. by 4in.
*152. Broken, rough, angular fragment. Calcareous *sandstone*, with *Serpula*, *Ostræa* or *Exogyra*, etc.: *Jurassic*. 12½in. by 10in. by ?
*154. Rounded, with nearly flat faces. Coarse, ferruginous *sandstone*, with rounded quartz grains: *Neocomian*. 15in. by 10in. by ?
160. Flat, worn slab. *Sandstone*: perhaps *Carboniferous*. 11½in. by 9in. by 5in. (?)
161. Triangular, worn slab, smooth, and angles but little rounded. Ferruginous *sandstone*: probably *Neocomian*. 11in. by 7in. by 6in.
169. Wedge-shaped, worn pebble. Ferruginous, calcareous *sandstone*: probably *Jurassic*. 7½in. by 6in. by 4in.
184. Worn slab. Coarse *sandstone* or *grit*: *Millstone-grit* almost certainly. 11in. by 9in. by 4in.
187. Worn, rough block. Fine ferruginous *sandstone*: probably *Neocomian*. 10in. by 6in. by 6in.
188. (See List I.)

LIST III.

Limestones.

9. Somewhat wedge-shaped, with two of its faces flat; generally smoothed and worn. Compact *limestone*: probably *Carboniferous*. 9½in. by 9in. by 5½in.
23. Apparently a fragment of a larger boulder, with flat surface of fracture. Other sides smoothed and rounded. Compact *limestone*: *Carboniferous or Oolite*. 13in. by 7in. by 6½in.
24. Smoothed and rounded. Compact *limestone*: *Mountain-Limestone* (*?*). 10in. by 6½in. by ?
58. Broken fragment, rounded and worn. Compact *limestone*: probably *Carboniferous*. 6in. by 5½in. by ?
75. Rounded, weather-worn, and marked irregularly by small cracks; doubtfully scratched on upper surface. *Carboniferous Limestone*. 11in. by 8in. by 7in.
78. Apparently a broken fragment. Irregular shape, somewhat angular, worn on one face. *Carboniferous Limestone*, containing fossils (*Spiriferæ*). 8in. by 7in. by 5in.
89. Rounded, worn, pear-shaped. *Limestone*: probably *Carboniferous*. 15in. by 11½in. by 7in.
93. Broken fragment, smoothed on one face. Black *limestone*: *Carboniferous*. 10½in. by 8in. by 5in.
104, 108. (See List I.)
*128. Flat, triangular pebble, angles worn. Fossiliferous, impure *limestone*: very like *Lias-Marlstone*. 10in. by 7in. by 4in.

*132. Rounded, worn pebble. Sandy *limestone*: probably *Jurassic*. 9in. by 7½in. by 5½in.
*135. Worn, smoothed, broken slab, slightly scratched. *Limestone*, with fossils: probably *Jurassic*. 7in. by 7in. by 2in.
*136. Rough, broken pebble. *Limestone*, with fossils: *Jurassic*. 4in. by 4in. by 3in.
*137. Broken piece, much rounded on original surface; apparently a piece of a nearly spherical boulder; a few scratches and grooves. *Limestone*: probably *Jurassic*. 9in. by 6in. by 3½in.
*140. Triangular, broken fragment; one face well smoothed, and scratched and grooved in various directions. *Limestone*: probably *Jurassic*. 8½in. by 7in. by 2in.
*142. Rough, angular slab (possibly not a boulder). *Limestone*, with fossils: probably *Mesozoic*. 19in. by 9in. by ?
*143. (See List I.)
*144. Broken, worn piece. *Carboniferous Limestone*. 9in. by 8in. by 6in.
*145. Rounded, worn pebble. Very hard, fossiliferous *limestone*: probably *Lias-Marlstone*. 9in. by 7in. by ?
*146. Rough, irregularly-shaped pebble, very slightly worn. Sandy *limestone*: very like *Lias-Marlstone*, with *Pecten* (*? æquivalvis*). 9in. by 6in. by 5½in.
*147. Rounded, worn, flattish boulder. Fossiliferous *limestone*: probably *Jurassic*. 12in. by 10in. (?) by 6in.
*153. Rounded, cuboidal block, surface rough. Calcareous *mudstone*, with *Ostræa* or *Gryphæa*: *Jurassic*, very like *Lias-Marlstone*. 13in. by 9½in. by ?
*155. Flat slab, angles worn. *Limestone*: probably *Carboniferous*. 10½in. by 10in. by 3in.
158. Angular slab, possibly slightly worn. Argillaceous *limestone*, with fossils: probably *Lias*. 11in. by 10in. by 4in.
175. Rounded, nearly spherical, smoothed. *Limestone*, with *Serpula*, etc.: *Jurassic*. 11in. by 8in. by 7in.

LIST IV.

Igneous Rocks.

30. Very uneven surfaces, covered with little knobs and depressions, broken on one side. *Granite*. 8½in. by 7in. by 5½in.
33. Rounded and smoothed. *Granite*. 7in. by 5in. by ?
66. Broken, rounded pebble. *Porphyrite*. 4in. by 4in. by 3in.
72. Rounded, many-sided block, surface rough and granular from exposure. *Granite*. 16in. by 14in. by ?
73. Smooth, worn, and rounded, shape somewhat irregular. *Basalt*; weathering dark blue. 21in. by 18in. by 12in.
90. Worn, somewhat prismatic in shape, angles rounded and sides flat. *Dolerite*. 15in. by 10in. by 7½in.
103. (See List I.)
186. Irregularly-shaped, smoothed and worn. *Dolerite*. 16in. by 9in. by 8in.

VI.

ON THE MICROSCOPIC STRUCTURE OF BOULDERS FOUND IN THE NORTH OF HERTFORDSHIRE.

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PLATES III—V.

The microscopic structure of erratic blocks has a two-fold interest. In the first place it has a special importance as being perhaps the only means by which igneous rocks can be identified with any approach to certainty. Fragments of sedimentary rocks generally have either some special character, or some included fossil, by which their original source may be easily known; but boulders of granite, basalt, schist, or other crystalline material are often so similar in general appearance that it is impossible, in many cases, from a mere macroscopic comparison, to determine the locality whence they have been conveyed. When, however, their minute structure is examined, there are often found certain mineralogical peculiarities, which, small and insignificant as they may appear, are yet sufficiently constant and characteristic to enable their parent rocks to be recognised.

In the second place, there is, in the study of rock-sections, a general interest which may perhaps be new to many members of a Society whose geological work lies so exclusively amongst the newer sedimentary deposits, and who may have, therefore, few opportunities of examining for themselves the various modes in which minerals aggregate into rock-masses, and the alterations which they experience by subsequent chemical action.

I will now proceed to describe the chief features of some specimens of boulders from the north of Hertfordshire kindly placed at my disposal by Mr. H. G. Fordham, and will afterwards draw any conclusions that may seem legitimate respecting their origin and petrographical peculiarities. It must, however, be remembered that a detailed examination of small weathered specimens is often a matter of considerable difficulty, and does not, in all cases, lead to such satisfactory conclusions as would be obtained from fresher samples.

The names of the localities and the numbers quoted are from the labels on the pieces of boulders as sent to me by Mr. Fordham, and (except those in italics) are the same as in his paper (see p. 33 *ante*) and in the Reports of the Boulder Committee of the British Association.

1. Dolerites.*

Ashwell, 186 (Pl. III, f. 1).—This is a moderately coarse, dark crystalline rock, with but little outward sign of decomposition: it contains visible crystals of felspar, pyroxene, and bright green grains of olivine.

* I have tried to separate the dolerites from the basalts, notwithstanding the difficulty, in some cases, of distinguishing any true glassy matrix.

Under the microscope the *felspar* * is seen to be wholly triclinic, occurring both in long, prismatic crystals, exhibiting the usual coloured striæ in polarised light, and in crypto-crystalline masses. It frequently contains long needles of *apatite*, which are especially abundant in the crypto-crystalline portions. With the exception of a little turbid grey matter, and a few brownish-yellow streaks in some of the crystals, the felspar appears but little altered. *Augite* occurs in well-formed brown and reddish-brown crystals, and in irregular grains: some of the forms exhibit the characteristic angle of augite, and have also a feeble dichroism, changing from purple-brown to yellowish-brown. Twin crystals appear to be rare. Magnetite is frequently enclosed. *Olivine* is plentiful, and has the usual appearance of alteration along lines of fracture: in some cases the whole crystal is changed to a yellowish-green chloritic or serpentinous substance, the margins being marked by a dark band of magnetite. *Magnetite* is present, both in large black patches, and as minute crystals enclosed in the other minerals. A few fragments of *biotite* may also be noticed.

Ashwell, 123 (Pl. III, f. 2).—A tolerably fresh, dark, crystalline rock, with green grains of olivine plainly visible.

Under the microscope the *felspar* appears to be wholly plagioclase, and but little altered. It contains numerous needles of *apatite*. In some portions of the rock, however, the whole of the felspar appears to have been converted into chloritic pseudomorphs. This is a marked feature of the rock, and should be useful for identification. *Augite* occurs both in isolated crystals and in aggregates. It polarises brilliantly, is but little decomposed, and contains crystals of magnetite. A little *biotite* appears, also, to be present. *Olivine* is present in large crystals, somewhat altered into a brownish-yellow substance (*chlorite*), and contains magnetite, occasionally altered into bright red hematite. Both *magnetite* and *titaniferous iron* occur scattered through the rock, and there are several red stains of ferric oxide, produced by secondary decomposition.

Ashwell, 90.—A dark crystalline rock, apparently fresh, and showing distinct crystals of felspar, pyroxene, and olivine.

Under the microscope the *felspar* is seen to be triclinic. It is abundant, and fairly unaltered, although occasionally converted into the usual grey granular substance. *Augite* occurs in isolated crystals, and in groups, and polarises brilliantly. *Olivine* is not so abundant as in the preceding specimens. It is sometimes completely altered into a chloritic substance, and often shows the characteristic mode of alteration in lines perpendicular to the fissures. It frequently contains crystals and grains of magnetite. *Magnetite* is plentiful, often in square and triangular sections. Some apparently rhombohedral forms of titaniferous iron may be noticed. *Apatite* is fairly abundant. A little *biotite* may be noticed. A few plates of a brownish-green chloritic substance, similar to the olivine pseudomorphs, occur in places.

* The names of the minerals detected by the aid of the microscope are printed in italics.

Ashwell (*small boulder from gravel-pit, Clay Bush Hill*, 2).—Very much weathered throughout to a greenish-grey mass, showing crystals of pyroxene, olivine, and apparently mica.

Beneath the microscope the *felspar* appears in well striated crystals of plagioclase, almost wholly filled, in parts, with the usual grey alteration-product. *Augite* appears to be the least altered mineral present. A notable feature is the unusually large amount of *biotite*, in strongly dichroic plates, with well-marked cleavage. *Olivine* was probably never very abundant, but is now almost entirely altered to fibrous, green, serpentinous pseudomorphs. *Magnetite* is not so plentiful as usual, and generally occurs in irregular patches, showing few characteristic square or triangular sections. *Apatite* is extremely abundant, and a few grains of *quartz* may be observed, evidently a secondary product. Green chloritic and brown ferruginous decomposition-products are scattered throughout the mass.

Ashwell, 19.—No fresh fracture occurs in this specimen for macroscopic examination.

Under the microscope the section appears much discoloured, and, in addition to *triclinic felspar*, *augite*, *magnetite*, and *apatite*, contains many large pseudomorphs of brownish-yellow and fibrous serpentinous matter, replacing the *olivine*. These pseudomorphs contain a great many *magnetite* enclosures, often arranged somewhat symmetrically, as in leucite and nepheline. There is also present a considerable quantity of a dingy-green, singly-refracting substance (? *chlorophæite*).

Ashwell, 103.—A very small specimen, much weathered.

Under the microscope it is seen to contain *triclinic felspar*, much altered, and containing numerous crystals of *apatite*. The *augite* is faintly dichroic. *Magnetite* is abundant. The *olivine* is completely altered, and there is a great deal of secondary chloritic matter, with a little *quartz*.

Kelshall, 1.—This specimen is too much weathered and discoloured to give satisfactory results beneath the microscope. Its leading features, however, are somewhat similar to the above.

Ashwell, 99.—A very small, weathered specimen.

Under the microscope it appears much discoloured by reddish-brown ferruginous matter. *Felspar* (plagioclase) is fairly abundant, and *augite*, *magnetite*, and *apatite* occur as usual. The *olivine* is so completely altered as to be scarcely recognisable. A little *biotite* and a few grains of *quartz* may be recognised.

Ashwell, 177.—Much decomposed throughout. *Felspar* is abundant, and *augite*, *magnetite*, and a little *biotite* occur. *Apatite* appears to be scarce, and *olivine* is not plentiful and is completely altered. A great deal of brown ferruginous matter discolours the rock.

Ashwell, 26.—Much decomposed and discoloured. *Felspar* much altered. *Olivine* scarce and much altered. *Magnetite*, *augite*, and *biotite* occur.

Hitchin, 2.—A dark crystalline rock, looking tolerably fresh.

Under the microscope there is an abundance of moderately fresh-looking *plagioclase*, enclosing crystals of *apatite*. The *augite* is brown in colour, and there are a few minute patches of a brown strongly dichroic substance, probably *biotite*. *Olivine* is not very abundant, and is altered completely. *Magnetite* is present as usual, and there is a considerable quantity of brown and yellow products of decomposition.

Ashwell, 51 (Pl. III, f. 3).—Black, crystalline rock, apparently fresh and undecomposed.

Beneath the microscope *olivine* appears to be tolerably abundant in semi-porphyritic crystals, which are seen in every stage of alteration, but the majority are clear and transparent, except along the cracks. The products of alteration appear to be the usual fibrous serpentinous substance, and a little *hematite* and *magnetite*. One crystal has enclosures of *magnetite* grains, arranged symmetrically around the margin, somewhat in the manner so characteristic of leucite and nepheline. *Felspar* is abundant, and apparently wholly triclinic: it is fairly unaltered, polarises brilliantly, and sometimes contains *apatite*. It occurs not only in distinct prismatic crystals, but also in crypto-crystalline masses, and is sometimes penetrated by a fibrous, interlacing system of lines showing incipient alteration. *Augite* occurs sometimes in well-formed crystals, sometimes in irregular patches. *Magnetite* is abundant, both in square sections, and in irregular patches.

2. Basalts.

Ashwell, 124 (Pl. III, f. 4).—A dark compact basalt, apparently rather decomposed. This is a very small specimen.

Under the microscope abundant crystals of *plagioclase* appear disseminated through a dark-brown granular-looking matrix, which is too opaque for any other crystals to be distinguished. The felspar encloses magnetite and frequently shows a brownish-yellow decomposition-product. *Magnetite* is abundant throughout, but neither *augite* nor *olivine* can be distinguished in the matrix.

Ashwell, 11 (Pl. III, f. 5).—A compact, bluish-black basalt, with semi-porphyritic crystals of olivine. This specimen looks fairly fresh.

Under the microscope there is seen to be a great deal of *olivine*, in comparatively large crystals, and many not much altered. Parts of the crystals are often converted into a fibrous, serpentinous or chloritic substance, and included crystals of *magnetite* are common. Some complete pseudomorphs of *serpentine* or *chlorite* occur. *Magnetite* is abundant, generally in well-marked cubical crystals, and a few rhombohedral sections are probably *titaniferous iron*. *Felspar* is abundant in rather small prismatic crystals, which, when they polarise well, show the characteristic striæ of plagioclase, but they are often so imbedded and mixed up with the ground-mass as to be scarcely recognisable. *Augite* often occurs in well-defined isolated crystals, possessing faint dichroism (purple-brown to brown), and enclosing grains of *magnetite*. A true glassy

matrix is undoubtedly present in considerable quantity, and abundant microliths are visible with a higher power. A good rock for the study of olivine pseudomorphs.

Ashwell, 25 (Pl. III, f. 6).—A dark, moderately fine-grained crystalline rock, decomposing on the outside into an earthy mass, with much red oxide-of-iron. Olivine is abundantly visible in greenish masses, and moderately large crystals of pyroxene are plentiful.

Under the microscope the most abundant constituent is seen to be *olivine*, which occurs both in irregular grains and in large semi-porphyritic crystals. As a rule it is not much altered except on the margins, and along the numerous cracks. The alteration-product is a fibrous, green substance resembling *serpentine*. It frequently encloses *magnetite*. *Felspar* is not in great abundance, and consists chiefly of plagioclase, frequently enclosing *apatite*. The pyroxenic element is *augite*, occurring in large brown patches often showing feeble dichroism (purple to brown). Patches of *magnetite* are common, generally in square sections. Magnificent *olivine* pseudomorphs occur also in this rock.

Ashwell, 125 (Pl. IV, f. 1).—A compact, dark basalt, of a greenish-grey colour. Small particles of pyrites are the only ingredients distinguishable.

Under the microscope the rock appears as a brownish, glassy matrix, in which are scattered grains of nearly unaltered *olivine*. *Augite* is also present in great abundance, in very minute crystals. *Felspar* appears to be very scarce, but grains and crystals of *magnetite* and *pyrites* are abundant.

Ashwell, 27 (Pl. IV, f. 2).—A black, compact basalt, showing green grains of olivine, and a few amygdaloidal cavities filled with calcite. A fairly fresh-looking specimen.

Beneath the microscope abundant crystals of plagioclastic *felspar* are seen in rather small crystals. *Olivine* is plentiful in rather large crystals and grains, and almost completely altered to a fibrous green serpentinous mineral. *Magnetite* is very abundant, showing chiefly square sections, but a few have the appearance of *titaniferous iron*. *Augite* appears to be much altered to a brownish, granular substance, and in some cases has completely disappeared, leaving only skeleton-crystals of black magnetite to mark its former existence. An abundance of microliths is to be observed in the glassy matrix. As secondary products, *serpentine*, *calcite*, and red patches of *ferric-oxide* occur.

3. Porphyrites.

Ashwell, 66 (Pl. IV, f. 3).—A purple, compact matrix, with felspar porphyritically imbedded, in tolerably large crystals. Specimen very small, and exposing no very fresh fracture. Much tarnished with red oxide-of-iron.

Under the microscope large crystals of *triclinic felspar* are seen, showing the characteristic twinning in a very marked degree, and containing numerous needles of *apatite*, greenish-yellow chloritic

matter, and also portions of the granular base. A considerable quantity of the usual turbid alteration-product is present in some of the crystals. The *pyroxene* is completely altered to a greenish-yellow fibrous substance, in many cases bounded by the usual outlines of the crystals. *Magnetite* is rather sparingly present.

The matrix is brown and granular, and appears to contain true glassy matter. Numerous minute veins ramify through it, infiltrated either with a brownish-red opaque substance (? *hematite*), or with a transparent doubly-refracting substance, probably *calcite*. The brown matter frequently has the appearance of broken skeletons, representing the fragmentary outlines of what may once have been crystals.

Ashwell, 141 (Pl. IV, f. 4).—A very small specimen, showing porphyritic crystals of felspar, imbedded in a purple, compact matrix.

Under the microscope the felspar is seen to consist of large crystals of *plagioclase*, and probably some *orthoclase*, although in many cases it is too much decomposed to give the usual optical characteristics. It is often greenish, in places, from admixture with chloritic matter and portions of the base. *Pyroxene* is only represented by a number of greenish pseudomorphs (*viridite*) sometimes surrounded by a ring of segregated iron. *Magnetite* is plentiful, and in part appears altered to *hematite*, which appears as red plates occasionally. The matrix is a greenish-grey, compact, granular mass, consisting of glassy matter, small crystals of *felspar*, altered *pyroxene*, and granules of *magnetite*. *Apatite* occurs sparingly both in the felspar and in the ground-mass.

Ashwell, 122 (Pl. IV, f. 5).—A compact, greenish, somewhat serpentinous-looking rock. With a pocket-lens minute lustrous specks are visible, having the appearance of mica.

Under the microscope shadowy porphyritic crystals of *felspar* appear in abundance; but they are so full of the ground-mass that they are difficult to identify optically. Some are undoubtedly triclinic. *Magnetite* is sparingly present, and mica is represented by *biotite*. *Chlorite* appears to be abundant in green scales, scattered through the base, and associated with it are small radiating nests of a strongly dichroic mineral, having the appearance of *actinolite*. The base is crowded with minute, transparent granules, which polarise brilliantly and are possibly silica. It is difficult to say whether any true glass is present or not.

4. Granites.

Ashwell, 72 (Pl. IV, f. 6).—A coarse-grained, grey granite: felspar apparently rather kaolinised.

Under the microscope the *felspar* appears almost entirely converted into an opaque cloudy mass, but showing occasionally, with polarised light, the characteristic appearance of *orthoclase*. *Quartz* occurs in moderately large masses, and containing many enclosures of *apatite* as well as stone and fluid cavities, the latter with the characteristic bubble. The mica appears to be wholly *biotite*, and

apparently contains a few enclosures. A few black patches, probably of *magnetite*, occur in places.

Ashwell, 33 (Pl. V, f. 1).—A rather coarse-grained granite, with an abundance of small silvery scales of muscovite. Felspar pink and rather kaolinised. A few black patches occur, which, when powdered, yield magnetic grains, and are probably magnetite.

Under the microscope the rock appears as a light brown, almost reticulated, mass of *quartz* and *mica*, with numerous dark fibrous streaks. The *felspar* is considerably decomposed, and no longer shows the characteristic structures with polarised light.

Ashwell, 30 (Pl. V, f. 2).—Rather coarse-grained admixture of orthoclase, quartz, muscovite, and a few black patches of biotite mingled with magnetite. The action of the magnet, together with blow-pipe tests, proves the comparative abundance of magnetite.

Under the microscope the *quartz* shows many concentric rings of colour, with polarised light (owing probably to varying thickness of the granules towards the margins). It contains many cavities, both stone and fluid, but no needles of *apatite* were noticed. The *felspar* is rather turbid from decomposition, and is chiefly orthoclase; but one or two crystals show the characteristic twinning of *plagioclase*. *Muscovite* appears to be abundant, and the black patches of *magnetite* are often associated with *biotite*, recognised by its strong dichroism.

Sandon (*from gravel-pit, near the Cat Ditch*, 3) (Pl. V, f. 3).—A greenish-looking, hornblendic granite, with much pink orthoclase, medium-grained, and not much decomposed: appears rather gneissic, but the specimen is too small to judge with certainty.

Under the microscope the felspar appears to be chiefly *orthoclase*; occasionally, however, there is a small patch of *plagioclase*. *Quartz* is not very abundant, and contains many stone and fluid cavities, sometimes of considerable size, but often so small as to appear, with $\frac{1}{4}$in. objective, only as patches and lines of cloudy spots. *Magnetite* is abundantly present, often in well-formed cubical crystals. Both *hornblende* and *biotite* occur plentifully. *Apatite*, however, does not appear to be present. A noticeable feature of this rock is the tendency of the quartz to aggregate into lines, as well as the occurrence of a few columnar, feebly-transparent crystals of an accessory mineral.

5. Gneiss and Schists.

Sandon (*from gravel-pit, near the Cat Ditch*, 4) (Pl. V, f. 4).—Very small specimen of an apparently gneissose rock, containing decomposed orthoclase, quartz, and mica. Foliation is well displayed by black bands, sparkling with mica, and yielding, when powdered, a considerable quantity of magnetite.

Under the microscope the rock appears as a confused mass of *felspar*, *mica* (probably *muscovite*), and *quartz*, with faint signs of foliation. The whole mass appears brownish, and the felspar is much decomposed. A little *biotite* may be recognised. *Magnetite* forms dark streaks and black grains throughout the mass. The

quartz is cloudy, and has many enclosed grains; but neither distinct fluid cavities nor apatite needles were noticed. No *plagioclase* could be distinguished with certainty.

Hitchin, 3 (Pl. V, f. 5).—A fine-grained, light-coloured gneiss with quartz and mica plainly visible.

Beneath the microscope, *orthoclastic felspar*, with a few crystals of *plagioclase*, is seen. A brown cloudy alteration-product frequently obscures the crystals. *Quartz* is present in irregular masses, often surrounded by mica. It contains cavities and a few enclosures, and a brownish decomposition-product has in some cases penetrated cracks in the granules. *Mica* is represented by *biotite* and *muscovite*, and some opaque matter, disseminated through the mass, may probably be *magnetite*. No accessory minerals were noticed, but the whole rock appears brown owing to alteration.

Ashwell, 150 (Pl. V, f. 6).—A dark green schist. Foliation well marked by bands of a dark green, very fibrous, hornblendic mineral.

Under the microscope the fibrous mineral appears to have the structure of *actinolite*, although some crystals of *hornblende* are present. Green plates and scales of *chlorite* are abundantly associated with the actinolite, which occurs in radiating crystals throughout the mass, as well as in the planes of foliation. The ground-mass appears to consist almost entirely of *quartz* granules, with here and there a cloudy mass, possibly of decomposed *felspar*. But little, if any, *magnetite* is visible.

Thus out of 27 specimens examined, 17 belong to the type of basic igneous rocks, 3 to the intermediate porphyrites, 4 are granites, and 3 are metamorphic (gneiss and schist). This large proportion of dolerites and basalts has an important bearing upon the origin of the boulders. For, if we consider the distribution of igneous rocks in Great Britain, we find that the Lower Silurian volcanic rocks of Wales and the English Lake District are chiefly acid in character; while in those of newer Palæozoic age, in the Midland counties and South Scotland, basic and intermediate rocks predominate. We have also to consider the very small area of exposed igneous rocks in the Midlands, in comparison with the large extent occupied by porphyrites, dolerites, and basalts in the South of Scotland. Thus there is, in the very classification of these boulders of Hertfordshire, an indication that their origin should be sought rather in a northerly than in a westerly direction. This view is strengthened by the great dissimilarity between the boulders, as a whole, when compared with the igneous rocks of the most considerable, as well as the nearest of the Midland districts, viz. Charnwood Forest.*

I will now attempt to examine briefly how far the mineralogical constitution of the boulders appears to throw light upon their origin; but my remarks must be taken not so much as advocating any distinct theory as to that origin, but rather as suggesting

* A typical collection of Charnwood rocks has been kindly sent to me by Mr. W. J. Harrison, F.G.S.

Tabular View of the Igneous Boulders of North Hertfordshire.

Class.	Texture.	Number of Specimen.	Leading Characteristics.	Suggested Localities for Comparison.
Dolerites ...	coarsely crystalline...	Ashwell, 186	Olivine plentiful (partly altered): felspar and apatite abundant...	These rocks bear the closest resemblance to the dolerites of the Midland counties and Scotland. The following are the chief localities: — Ponk Hill, Rowley Hills, Clee Hills, Kinlet, Whitwick, Shatterford, Swinnerton Park, Matlock, Whin Sill of Northumberland and Durham, and central valley of Scotland, where the localities are too numerous to mention, some of the better-known being Arthur's Seat, Dalmahoy, Ratho, Springfield, Dalmeney Park, Lenny, North Queen's Ferry, Campsie Fells, Neilston, and Clyde basin coal-field.
	,, ,, ...	Ashwell, 123	Olivine plentiful (partly altered): yellow felspar pseudomorphs ... ...
	,, ,, ..	Ashwell, 90...	Olivine scarcer (much altered): a little biotite ... ...
	,, ,, ...	Ashwell, 2 ...	Olivine quite altered: biotite more plentiful ... ..
	,, ,, ...	Ashwell, 19...	Olivine quite altered: much serpentinous and chloritic matter ... ...
	,, ,, ...	Ashwell, 103	Olivine quite altered: a little quartz ... ...
	,, ,, ...	Kelshall, 1 ...	Olivine quite altered: much decomposed ... ...
	,, ,, ...	Ashwell, 51...	Olivine plentiful, partly altered ... .
	,, ,, ...	Ashwell, 99...	Olivine quite altered: biotite and quartz ... ...
	,, ,, ...	Ashwell, 177	Olivine scarce and altered ... ...
	,, ,, ...	Ashwell, 26..	Olivine scarce and altered: biotite present ... ...
	,, ,, ...	Hitchin, 2 ...	Olivine scarce and altered: biotite present .. ..
Basalts.....	micro-porphyritic ...	Ashwell, 124	Olivine indistinguishable: felspar abundant ... ...
	,, ,, ...	Ashwell, 11...	Olivine abundant (partly altered)... ... ...
	,, ,, ...	Ashwell, 25...	Olivine abundant (partly altered): felspar scarce ..
	,, ,, ...	Ashwell, 125	Olivine fresh: pyrites present ... ...
	,, ,, ...	Ashwell, 27...	Olivine much altered: augite pseudomorphs ... ...
Porphyrites	porphyritic	Ashwell, 66...	Porphyritic crystals of felspar and pseudomorphous pyroxene	These bear much resemblance to the porphyrites of the Cheviot Hills.
	,, ...	Ashwell, 141	
	,, ...	Ashwell, 122	Presence of chlorite and actinolite ... ...
Granites ...	medium grained ...	Ashwell, 72...	Grey: felspar opaque: biotite and magnetite	Scotch granites, and possibly those of English Lake District.
	,, ,, ...	Ashwell, 33...	Pink orthoclase and brown muscovite .. ..
	,, ,, ...	Ashwell, 30...	Orthoclase and a little plagioclase: muscovite and biotite ... ...
	finer ,, ...	Sandon, 3 ...	Greenish syenitic granite	Charnwood Forest.
Gneiss and Schist ...	foliated	Sandon, 4 ...	Gneissose admixture of orthoclase, quartz, and mica.	
	,, ...	Hitchin, 3 ...		
	,, ...	Ashwell, 150	Actinolite schist ... ...

localities which appear most likely to repay an actual comparison. No one, having read Mr. Allport's description of the British Carboniferous dolerites,* can fail to recognise the very great similarity between them and the doleritic boulders of Hertfordshire; and, although complete identification from written descriptions would be impossible, there are some considerations which lead me to the conclusion that it is amongst the Scotch dolerites, rather than those of the Midlands, that we may expect to find the counterparts of the rocks under present discussion. There appear to be certain features which are more especially characteristic of the Scotch specimens examined by Mr. Allport, and these are the presence of *biotite*, the occurrence of *quartz* as a secondary constituent, the presence of *olivine* partially converted into *hematite*, and the common occurrence of serpentinous and chloritic olivine pseudomorphs. Now these characters have one and all been noticed in several of the specimens described above, and, in addition, it may be mentioned that the chloritic-felspar pseudomorphs, observed in the specimen labelled *Ashwell*, 123, are also characteristic of several Scotch dolerites, notably, as far as my own specimens are concerned, in samples from Airdrie and Burnt Island. Without, therefore, venturing to assert that the dolerites are of Scotch origin, I think there is, at least, sufficient evidence to render comparison advisable with the Scotch rocks before those of the Midland counties.

Turning now to the porphyrites, I know of no localities nearer than the Cheviot Hills whence these rocks could have been derived; but here again I am speaking on the authority of written descriptions, and not of actual comparison. On reading Mr. Harris Teall's paper "On the Cheviot Andesites and Porphyrites," † with these Hertfordshire porphyrites before me, I could scarcely believe that the specimens were not identical. A comparison should certainly be made in this case, and I have little doubt but that the original abode of these boulders will be found to be either in the Cheviots, or amongst the hill-ranges of South Scotland.

The granitic and gneissose rocks present considerably more difficulty, although perhaps the localities of British granites are far better known than those of other igneous rocks. The specimen labelled *Ashwell*, 72, bears a strong resemblance to a section in my cabinet from Dalbeattie's quarries, Kirkcudbright, and the specimen labelled *Sandon*, 3, might be a finer-grained variety of one of the so-called syenites from Charnwood Forest. Other possible localities are the English Lake District and the Grampians, of which, judging from the other specimens, the latter would be the more probable.

It must not be forgotten, however, that during the Glacial epoch an ice-sheet probably extended over what is now the German Ocean, from Scandinavia to our eastern shores, and it is not impossible that some of the Hertfordshire boulders may have had a more distant source than the limits of our own islands.

* 'Quart. Journ. Geol. Soc.,' vol. xxx, p. 529 *et seq.*

† 'Geol. Mag.,' decade ii, vol. x, pp. 97, 145, 252.

EXPLANATION OF THE PLATES.

Plate III.

Fig. 1. (Ashwell, 186).—Section of dolerite showing long prisms of *felspar*, small needles of *apatite*, and irregular masses of *augite*.

,, 2. (Ashwell, 123).—Section of dolerite showing large crystals of *olivine*, traversed by fissures, opaque *magnetite*, prismatic crystals of *felspar*, and irregular masses of *augite*.

,, 3. (Ashwell, 51).—Section of dolerite. The centre shows incipient alteration of *felspar* along interlacing fibrous lines; crystals of *magnetite*, *plagioclase*, and *augite* surround the central mass.

,, 4. (Ashwell, 124).—Section of basalt showing transparent crystals of *felspar*, black specks of *magnetite*, and a granular matrix.

,, 5. (Ashwell, 11).—Section of basalt showing semi-porphyritic crystals of *olivine*, small prisms of *felspar*, and a few isolated *augite* crystals.

,, 6. (Ashwell, 25).—Section of basalt showing large crystals of *olivine* altered along the lines of fissure.

Plate IV.

Fig. 1. (Ashwell, 125).—Section of fine-grained basalt with transparent masses of *olivine*.

,, 2. (Ashwell, 27).—Section of basalt showing large crystals of altered *olivine*. The small black crystals are *magnetite*; the transparent prisms are *plagioclase* enclosed in a glassy matrix with many microliths.

,, 3. (Ashwell, 66).—Section of porphyrite showing large crystals of *plagioclase* with *augite* pseudomorphs in a granular matrix.

,, 4. (Ashwell, 141).—Section of porphyrite showing porphyritic *felspar* crystals in a granular matrix.

,, 5. (Ashwell, 122).—Section of porphyrite (highly magnified) showing the matrix with scales of *chlorite* and radiating nests of *actinolite*.

,, 6. (Ashwell, 72).—Section of granite showing transparent masses of *quartz* (with fluid and other enclosures), cloudy *felspar*, and *biotite* (with enclosures).

Plate V.

Fig. 1. (Ashwell, 33).—Section of granite showing abundance of *quartz* granules and some opaque *magnetite* and cloudy *felspar*.

,, 2. (Ashwell, 30).—Section of granite. The transparent granules are *quartz*, the crystals with strong parallel cleavage are *muscovite*; black patches of *magnetite* and cloudy *felspar* are also seen.

,, 3. (Sandon, 3).—Section of hornblendic granite showing masses of *quartz* (transparent), *magnetite* (opaque), *felspar* (striated), and a large *hornblende* crystal (near the centre).

,, 4. (Sandon, 4).—Section of gneiss showing black streaks of *magnetite*, transparent *quartz*, and striated crystals of *mica*.

,, 5. (Hitchin, 3.)—Section of gneiss showing *quartz* (transparent), *mica* (striated), and *felspar* (cloudy).

,, 6. (Ashwell, 150).—Section of schist showing bundles and radiating groups of *actinolite* crystals in a matrix of *quartz* granules.

VII.

NOTES ON LEPIDOPTERA OBSERVED IN THE NEIGHBOURHOOD OF SANDRIDGE, HERTS.

By A. F. Griffith, M.A.

Read at Watford, 18th March, 1884.

The notes that I have to lay before you this evening will chiefly be interesting as showing what has to be done by some energetic members of our Society before we can be said to have even well begun our work in the compilation of a catalogue of the Lepidoptera of Hertfordshire. Even the nucleus for such a catalogue has hitherto been wanting, and it is in the hope that the subjoined list may form such a nucleus, that I have ventured to bring before you this paper.

In the principal works on Entomology our county is barely mentioned. The Rev. F. O. Morris, in his work on 'British Butterflies,' records but six species as occurring in it, and even of these, one (*Coenonympha Davus*) seems to have been included by mistake, as it is stated to occur on Barnet Heath, scarcely a probable locality for this moor-loving species. Stainton, in his invaluable 'Manual,' does not, to the best of my knowledge, mention any one species as occurring in the county. Newman also passes it over almost in silence. From these facts it may be inferred that the systematic pursuit of Entomology, or at least the recording of species of Lepidoptera, has hitherto been very much neglected in Hertfordshire.

It will be seen, however, from the subjoined list that our Society cannot plead any special poverty in the county fauna as an excuse for this neglect. The list merely gives the species which have been observed by my brother, Mr. F. Ll. Griffith, and myself, in a district about 6 miles long and 2 miles wide, having the village of Sandridge at about its middle point. The observations also have been very unsystematic, whole months together having frequently gone by when neither my brother nor I have been at home, so that no notes could be taken. Thus we have scarcely any means of knowing what species occur during May and the early part of June. Never, also, having made much use of the well-known methods of "sugar" and "light," the list of Noctuæ must give a very inadequate notion of the number of species which are to be found in the district. In fact, the list is published in the hope that others, noticing so many omissions in it, will be impelled to fill them up; and not at all from any idea that it may be considered as even approaching completion.

Our list of 29 species of butterflies, distributed among 14 genera, includes no rarities, and calls for few remarks. It includes considerably less than half of our 66 acknowledged British species. Most of them occur commonly. *Colias Hyale*, however, is an exception, as we have only observed two specimens, both seen in the autumn of 1875. *C. Edusa* also has never been common, except in

the extraordinary season of 1876, when it abounded from the middle of June till the middle of September. That same year I met with it wherever I went, the most unlikely place perhaps being at Harlech, in North Wales. The pale variety of the female (*Helice*) was not uncommon that year at Sandridge, my brother taking ten of them in a few days. *Cynthia cardui* is occasionally plentiful, but as usual very uncertain in its appearance. *Thecla W-album* and *Polyommatus Argiolus* are also not common, while of *Argynnis Adippe* I have noticed but one specimen, at Symond's Hyde.

Of the Sphinges and other Nocturni, our list includes 42 species representing 24 genera. Three specimens of *Sphinx convolvuli* were brought to me in the month of September, 1874, and I took one at rest on a frame in our garden the following year. The Clearwings are represented only by *Macroglossa bombyliformis*, *Sesia tipuliformis*, and *S. bembeciformis*. I remember to have seen in some old number of a magazine an account of certain captures in Hertfordshire, near Elstree, and that amongst them *S. myopiformis* was mentioned. No doubt this and several other species are to be found at various places within the county.

Of the Geometrina 51 genera are represented by 125 species; of the Pseudo-bombyces, 9 genera, 18 species; of the Noctuina, 49 genera, 113 species; of the Deltoidæ, 3 genera, 4 species; of the Pyralidina, 14 genera, 29 species;* of the Crambites, 7 genera, 19 species; and of the Tortricina, 46 genera, 125 species. Of the Tineina our list as yet only includes about 150 species, so that I have omitted it for the present. Of the 3 genera of Pterophorina, 2 are represented, but by 9 species only.

Few of these species seem to call for special remark. Some appear to occur here but rarely, such as *Ennomos erosaria*, *Cabera rotundaria*, *Eupithecia plumbeolata*, *Lobophora hexapterata*, *Notodonta chaonia*, *Leucania comma*, *Cirrhoedia xerampelina*, *Dianthœcia conspersa*, and *Heliothis armigera*, one specimen of the last having occurred, which my brother took on a sun-flower in our garden in September, 1873. *Anticlea rubidata*, *Cucullia verbasci*, and *Heliothis marginatus* are as usual very uncertain in their appearance, but sometimes are abundant. *Abraxas ulmata* is limited so far as I know to a small area, being abundant near Batchwood, but not to my knowledge occurring nearer Sandridge. I have to thank Mr. A. Lewis, of St. Albans, who has also succeeded in capturing a good number of other species near St. Albans, for telling me of the locality for this species. In all, our list (which does not, it must be remembered, include the Tineina) comprises 514 species, out of a total of about 1350 known to occur in Great Britain.

The county of Hertford is scarcely one which would be chosen by an entomologist for collecting in, but yet it presents several advantageous features to any one who has sufficient leisure to hunt it thoroughly. And perhaps it will not be a waste of

* The anomalous species *Aventia flexula* has occurred, though rarely.

time to indicate briefly what localities may be expected best to repay investigation. The chalk-slopes which bound the county with few breaks from Royston to Berkhamsted will no doubt yield a rich harvest of insects to any one who will hunt them systematically. I myself spent a couple of hours collecting in a very high wind on Royston Down one day last August, and even under these unfavourable conditions succeeded in finding three species of Tortrices which I had not previously met with in the county. Here we may expect to find at least three or four additional species of blue butterflies and the silver-spotted skipper, all of which I have taken a few miles off on similar chalk-slopes in Cambridgeshire. In the beech-woods near the borders of Buckinghamshire we ought to find *Lithosia helvola* and *aureola*, *Demas coryli*, and many other species. Perhaps some fortunate collector may there meet with the very rare *Ennomos alniaria*, for it was only just over our border that the late Mr. Harpur Crewe found a larva of this species, which unfortunately emerged in a crippled condition. Here, too, *Ptilophora plumigera* and *Notodonta cucullina* may be expected among maples, *Eupithecia togata* among spruce-firs, and *E. arceuthata* among junipers, while the seed-pods of *Campanula Trachelium* should be searched at the end of August for *Eupithecia campanulata*, and the flowers of the foxglove for *E. pulchellata*. In fact, our list probably does not include more than half the species of the genus *Eupithecia* which occur in the county. We may safely expect, also, that an immense number of peculiar *Pyrales*, *Crambites*, and other Micros, will reward a careful search along these chalk-hills, the peculiar vegetation of which always supports a large and varied fauna.

With the exception of this comparatively narrow strip, the whole of Hertfordshire consists of undulating country, for the most part well wooded, and with a great variety of subsoils, nearly all however, overlying the chalk and varying from the very heavy clay to the hardest gravel, and, in a few spots, the lightest sand. With the exception of the river valleys, of which more anon, the fauna of the whole of this division of the county may be expected to be on the whole fairly uniform, and it is in a small district of this character that the species mentioned in the accompanying list have been observed. I will therefore not delay over this part further, except to reiterate what I said at the beginning of the paper, that the subjoined list is not to be thought at all complete. My brother and I have yearly added a considerable number of species to it. Last year we added over 15 species; and the great variety of subsoils, which makes it very necessary to hunt each locality thoroughly, at the same time makes it highly improbable that more than a part only of the species inhabiting this division have as yet been observed. In fact, scarcely any of the numerous inhabitants of fir woods, and none of the alder-feeders, figure in our list at all.

Lastly, with regard to the river-valleys, neither my brother nor myself have ever had an opportunity of working these mines of

entomological wealth. The rivers Lea and Ver run through parts of our district, but night-work is very necessary for marsh insects, and this we have not attempted. Near Hatfield are some capital reed-beds; and there are many other likely spots near Welwyn and Hertford, and in fact scattered all over the county, where, among osier-beds and reed-beds, with their attendant rich vegetation, rare species are no doubt to be obtained. Some years ago I found traces of larvæ in reeds near Wheathampstead which I have no doubt were *Calamia phragmitidis*. But *Nonagria neurica* and *geminipuncta*, *Leucania straminea*, and other rarities are almost certainly to be found in some of these spots. A friend of mine has told me that he has seen *Acentropus niveus* on the canal near Hemel Hempstead, and I have taken *Nudaria senex* plentifully on the Lea where *Elachista poæ* and *E. monticola* also occur, so that any one who is determined to hunt such spots may be sure of getting at any rate something to reward him.

In conclusion, I may be allowed to express the hope that the comparative length of this paper in proportion to the small amount of novel matter contained in it will be excused. If what I have said should lead but one or two persons to make systematic researches into the entomology of their own neighbourhood, it will have so far succeeded in its aim. Any one residing in a district has immense advantages in studying its natural history, over one who like myself only attacks it from a distance. And I very much hope that any members who have made such investigations or may intend to do so will not fail to communicate either with one of the Secretaries of our Society or with myself, and from time to time give the Society the benefit of their knowledge.

But there is one suggestion that I should like to make in order to prevent mistakes creeping into our list; namely, that each insect taken in the county should be labelled with a distinctive mark. A very simple plan and one that takes but little time is as follows:— Choose certain letters to denote certain localities; thus, S might stand for Sandridge, R for Royston, Wd for Wheathampstead, Wn for Welwyn, and so on; several rows of each of these marks can then be written very small on thin note-paper, and when a number of specimens are ready to be taken off the setting-board, it is easy to cut off a row, cut it up into little labels, and stick the pin of each moth through one of them. If a key to the abbreviations be kept with the moths, it is easy by this method to be sure of the locality of each specimen, and thus an additional interest is given to one's collection. Without some such plan, it is surprising how soon we may become uncertain as to the locality of some insect which we perhaps did not recognise at the time of capture, or for some other reason did not notice particularly; and this uncertainty is a fruitful source of error in local lists.

Appendix.

List of Lepidoptera (exclusive of the Tineina) observed in the neighbourhood of Sandridge, Herts, by A. F. Griffith and F. Ll. Griffith.

RHOPALOCERA.

Diurni.

Pieris
brassicæ
rapæ
napi
Anthocharis
cardamines
Gonepteryx
rhamni
Colias
Edusa
Hyale
Argynnis
Paphia
Adippe
Selene
Vanessa
urticæ
polychloros
Io
Atalanta
cardui
Satyrus
Megæra
Janira
Tithonus
Hyperanthus
Chortobius
Pamphilus
Thecla
quercus
Thecla
W-album
Polyommatus
Phlæas
Lycæna
Alexis
Argiolus
Syrichthus
alveolus
Thanaos
Tages
Hesperia
Sylvanus
linea

HETEROCERA.

Nocturni.

Smerinthus
ocellatus
populi
tiliæ
Sphinx
convolvuli
ligustri
Chærocampa
porcellus
Elpenor
Macroglossa
stellatarum
bombyliformis
Sesia
tipuliformis
bembeciformis
Zeuzera
æsculi
Cossus
ligniperda
Hepialus
Hectus
lupulinus
Hepialus
sylvinus
humuli
Procris
statices
Zygæna
filipendulæ
Nola
cucullatella
Nudaria
senex
mundana
Lithosia
mesomella
complanula
griseola
Euchelia
jacobeæ
Chelonia
Caja
Arctia
mendica
lubricipeda
Arctia
menthastri
Liparis
auriflua
salicis
monacha
Orgyia
pudibunda
antiqua
Trichiura
cratægi
Pœcilocampa
populi
Eriogaster
lanestris
Bombyx
Neustria
quercus
Odonestis
potatoria
Lasiocampa
quercifolia

Geometrina.

Uropteryx
sambucata
Rumia
cratægata
Angerona
prunaria
Metrocampa
margaritata
Pericallia
syringaria
Selenia
illunaria
illustraria
Odontopera
bidentata
Crocallis
elinguaria
Ennomos
fuscantaria
erosaria
angularia
Himera
pennaria
Phigalia
pilosaria
Nyssia
hispidaria
Amphidasis
prodromaria
betularia
Cleora
lichenaria

Boarmia
repandata
rhomboidaria
Pseudoterpna
cytisaria
Geometra
papilionaria
Iodis
vernaria
lactearia
Hemithea
thymiaria
Ephyra
porata
punctaria
omicronaria
pendularia
Asthena
luteata
candidata
Acidalia
scutulata
bisetata
osseata
remutata
imitaria
aversata
emarginata
Timandra
amataria
Cabera
pusaria
rotundaria
exanthemaria
Corycia
temerata
Macaria
liturata
Halia
Wavaria
Strenia
clathrata
Panagra
petraria
Fidonia
atomaria
Abraxas
grossulariata
ulmata

Ligdia
adustata
Lomaspilis
marginata
Hybernia
rupicapraria
leucophearia
aurantiaria
progemmaria
defoliaria
Anisopteryx
æscularia
Cheimatobia
brumata
Oporabia
dilutata
Larentia
didymata
pectinitaria
Emmelesia
alchemillata
albulata
decolorata
Eupithecia
venosata
linariata
centaureata
succenturiata
subfulvata
plumbeolata
isogrammata
castigata
lariciata
pimpinellata
fraxinata
nanata
vulgata
absynthiata
assimilata
abbreviata
exiguata
sobrinata
coronata
rectangulata
Lobophora
hexapterata
Thera
variata

Ypsipetes
elutata
Melanthia
ocellata
albicillata
Melanippe
procellata
unangulata
rivata
subtristata
montanata
fluctuata
Anticlea
rubidata
badiata
derivata
Coremia
propugnata
furrugata
unidentaria
quadrifasciaria
Camptogramma
bilineata
Phibalapteryx
tersata
vitalbata
Scotosia
dubitata
vetulata
rhamnata
undulata
Cidaria
miata
picata
corylata
russata
immanata
suffumata
silaceata
testata
fulvata
pyraliata
dotata
Eubolia
mensuraria
palumbaria
lineolata
Anaitis
plagiata

Pseudo-bombyces.

Platypteryx
lacertula
hamula
Cilix
spinula
Dicranura
furcula
bifida
Vinula

Petasia
Cassinea
Pygæra
bucephala
Clostera
curtula
Ptilodontis
palpina
Notodonta
camelina

Notodonta
dictæa
dromedarius
ziczac
trepida
chaonia
dodonæa
Diloba
cæruleocephala

Noctuina.

Cymatophora
diluta
Or
Bryophila
Perla
Acronycta
psi
leporina
aceris
megacephala
ligustri
rumicis
Leucania
conigera
lithargyria
comma
impura
pallens
Nonagria
fulva
typhæ
Gortyna
flavago
Hydræcia
nictitans
micacea
Axylia
putris
Xylophasia
lithoxylea
polyodon
hepatica
Neuria
saponariæ
Heliophobus
popularis
Cerigo
Cytherea
Luperina
testacea
Mamestra
anceps
brassicæ
persicariæ
Apamea
basilinea
gemina
oculea
Miana
strigilis
furuncula
Grammesia
trilinea
Caradrina
Morpheus

Caradrina
alsines
blanda
cubicularis
Rusina
tenebrosa
Agrotis
suffusa
saucia
segetum
exclamationis
porphyrea
Triphæna
janthina
interjecta
orbona
pronuba
Noctua
augur
plecta
C-nigrum
triangulum
rhomboidea
brunnea
festiva
rubi
umbrosa
xanthographa
Tæniocampa
gothica
rubricosa
instabilis
stabilis
gracilis
munda
cruda
Orthosia
lota
Anchocelis
rufina
pistacina
lunosa
litura
Scopelosoma
satellitia
Xanthia
cerago
silago
ferruginea
Cirrhoedia
xerampelina
Tethea
subtusa
retusa

Cosmia
trapezina
diffinis
affinis
Dianthœcia
capsincola
cucubali
conspersa
Hecatera
dysodea
serena
Epunda
viminalis
Miselia
oxyacanthæ
Agriopis
aprilina
Phlogophora
meticulosa
Euplexia
lucipara
Hadena
Proteus
dentina
chenopodii
oleracea
thalassina
Xylocampa
lithoriza
Cucullia
verbasci
umbratica
Heliothis
marginata
armigera
Heliodes
arbuti
Abrostola
urticæ
Plusia
chrysitis
iota
gamma
Gonoptera
libatrix
Amphipyra
pyramidea
tragopogonis
Mania
maura
Catocala
nupta
Euclidia
Mi

Deltoidæ.

Hypena
proboscidalis

Rivula
sericealis

Herminia
tarsipennalis
griscalis

AVENTLÆ.

Aventia flexula

PYRALIDINA.

Pyralis
fimbrialis
farinalis
glaucinalis
Aglossa
pinguinalis
cuprealis
Pyrausta
purpuralis
Herbula
cespitalis
Endotricha
flammealis
Cataclysta
lemnalis
Hydrocampa
nymphæalis
Botys
verticalis
urticalis
Ebulea
crocealis
sambucalis
Pionea
forficalis
Spilodes
cinctalis
Scopula
lutealis
olivalis
Scopula
prunalis
ferrugalis
Stenopteryx
hybridalis
Scoparia
ambigualis
basistrigalis
cembræ
dubitalis
mercurella
cratægella
resinea
truncicolella

CRAMBITES.

Crambus
pratellus
pascuellus
pinetellus
perlellus
tristellus
inquinatellus
geniculeus
culmellus
Crambus
hortuellus
Schœnobius
forficellus
Ephestia
elutella
Phycis
betulella
roborella
Rhodophæa
consociella
advenella
marmorea
tumidella
Melia
sociella
Meliphora
alveariella

TORTRICINA.

Halias
prasinana
quercana
Tortrix
pyrastrana
xylosteana
sorbiana
rosana
transitana
heparana
ribeana
corylana
unifasciana
costana
viridana
ministrana
adjunctana
Branderiana
Dichelia
Grotiana
Leptogramma
literana
Peronea
favillaceana
perplexana
comparana
Schalleriana
variegana
hastiana
Peronea
aspersana
Teras
caudana
contaminana
Dictyopteryx
Lœflingiana
Holmiana
Bergmanniana
Forskaleana
Argyrotoza
Conwayana
Ptycholoma
Lecheana
Ditula
semifasciana
Penthina
betulætana
pruniana
cynosbana
ochromelana
carbonana
Spilonota
ocellana
dealbana
suffusana
rosæcolana
roborana
Pardia
tripunctana
Aspis
Udmanniana
Sericoris
conchana
lacunana
urticana
Mixodia
Ratzburghiana
Euchromia
purpurana
Orthotænia
striana
Phtheochroa
rugosana
Cnephasia
musculana
Sciaphila
nubilana
pascuana
subjectana
virgaureana
communana
alternana
hybridana
Bactra
lanceolana

Phoxopteryx
siculana
Lundana
ramana
Grapholitha
Paykulliana
Nisana
cinerana
nigromaculana
Campoliliana
trimaculana
Penkleriana
nævana
Phlæodes
tetraquetrana
Hypermecia
cruciana
Batodes
angustiorana
Pœdisca
corticana
profundana
ophthalmicana
Solandriana
semifuscana
Ephippiphora
bimaculana
Cirsiana
Brunnichiana
Ephippiphora
fœneana
trigeminana
gallicolana
Semasia
spiniana
janthinana
rufillana
Wœberana
Coccyx
splendidulana
argyrana
Hyrciniana
nanana
Retinia
pinicolana
Carpocapsa
splendana
Pomonana
Endopisa
pisana
Stigmonota
composana
Dicrorampha
sequana
Petiverana
ulicana
plumbagana
acuminatana
simpliciana
Pyrodes
Rheediella
Catoptria
ulicetana
hypericana
Scopoliana
Hohenwarthiana
Trycheris
mediana
Xylopoda
Fabriciana
Eupœcilia
nana
maculosana
angustana
Xanthosetia
zoegana
hamana
Chrosis
tesserana
Audouinana
Argyrolepia
Baumanniana
badiana
cnicana
Cochylis
Smeathmanniana
Tortricodes
hyemana

Pterophorina.

Pterophorus
Bertrami
phæodactylus
bipunctidactylus
Pterophorus
Loewii
fuscodactylus
pterodactylus
spilodactylus
Pterophorus
pentadactylus
Alucita
polydactyla

VIII.

NOTES ON MOSSES; WITH A PRELIMINARY HERTFORDSHIRE MOSS-FLORA.

By A. E. Gibbs.

Read at Watford, 18th March, 1884.

One of the principal objects of a local Natural History Society should be to thoroughly and systematically record the indigenous productions of the country embraced within the area of its operations, and as our own Society can point to so much valuable work done in various directions during the period of its existence, I am tempted to draw your attention to a few facts with regard to a class of plants which, up to the present, do not seem to have attracted much notice in the county. I will endeavour to give some little information about the Musci, and a preliminary list of species recorded during the past eighteen months from various Hertfordshire localities, with the result also of an examination of the mosses in the late Rev. W. H. Coleman's herbarium, now in the possession of the Society.

The main object of these few notes is to endeavour to induce more of our members to turn their attention to these little-regarded but interesting plants. The species found by myself were nearly all growing within a few miles of St. Albans, so I shall be very glad if any one will send me specimens from distant parts of the county, recording the exact locality in which each species was gathered. I shall be happy to return specimens when asked to do so, and also to assist members to the best of my ability to name their finds.

At the end of the 'Flora Hertfordiensis' is a list of the Hertfordshire Mosses which were known to the Rev. W. H. Coleman. I have gone carefully through it, and have also examined the specimens themselves, which have come into the possession of the Society, and they prove that our Moss Flora is comparatively rich in species and will well repay careful investigation. Since I have acted as Recorder, I have noted the occurrence of about 130 species, including those found by Mr. Coleman.

Moss-hunting is a pursuit which can be carried on by the botanist not only during the bright days of summer, but also and more especially during the dark dull winter months, when attention is less likely to be fully occupied by the larger and more highly-organised members of the Vegetable Kingdom. Every hedge-bank and old wall will make a good hunting-ground, for some kind of moss will be found thriving under any variety of circumstances. How they cover the old tree stump with a delicate embroidery of green, hiding decay and making death itself beautiful! Can we conceive a more picturesque object in the landscape than an old shed or ruined cottage with its thatched roof converted into a perfect nursery of *Hypna* and *Tortulæ*? These little plants even adorn the tomb itself, creeping over the time-worn stones in our older and more-neglected graveyards, and they conspire with their near

allies, the lichens, to clothe them with a delicately-tinted vesture, thus beautifying what has been forsaken by man. Mosses are to be found both on the mountain and in the bog; many species, such as the *Orthotricha*, grow on trees, while some, like many of the *Splachna*, are to be found only on the exuviæ of herbivorous and carnivorous animals. As in the case of the higher plants, different species occur on the outcrops of different geological formations. Thus on a steep chalk cutting or cliff we may look for *Seligeria calcaria*, while *S. recurvata* prefers sandstone rocks. The rare *S. paucifolia*, which is recorded from but few localities, but which we had the good fortune to find in the Tunnel Woods last autumn, grows on detached chalk nodules partly buried in the soil. The *Sphagna* which form the greater portion of the peat in peat bogs, are a very interesting genus, but unfortunately are not very largely represented in our county, a fact due doubtless to the very little bog-land to be found in Hertfordshire, and which through drainage is yearly becoming less. I have only discovered *Sphagnum subsecundum* and one or two of its varieties in the neighbourhood of St. Albans. The *Phasca* mostly affect fallow fields, the *Grimmiæ* dry rocks and walls, while a *Hypnum* may be found almost anywhere.

Mosses, it need scarcely be said, are Cryptogams, but they belong to the higher and more-developed division of that class. All plants lower than mosses are thallophytes, that is to say, they have no distinct leaf and stem, but, like the algæ, fungi, and lichens, have the two combined in a cellular, filamentous or flattened leafy expansion. But when we get so high in the scale of vegetation as the Musci, we find that Nature has taken a new departure, and we get the two great groups of organs—the foliar and the axial. Root, stem, and leaves are present, and in the wonderful contrivances for their fertilisation we get the key to the plan adopted by Nature in the more fully developed Phanerogamia. "There is nothing," says the Rev. Hugh Macmillan,* "in the appearance or structure of the lichens, fungi, or algæ, to remind the popular mind of higher plants; they form, as it were, a strange microcosm of their own—a perfectly distinct and peculiar order of vegetable existence. But when we ascend a step higher and come to the mosses, we find for the first time the rudimental characters and distinctions of root, stems, branches, and leaves — we recognise an ideal example of the flowering plants, all of whose parts and organs are, as it were, sketched out in anticipation, in these simple and tiny organisms." The stem in some of the mosses is very rudimentary, as in the *Seligerieæ*, while in others, as in the Polytricheaceæ, it is strongly developed. As the mosses are the lowest plants producing a true stem-axis distinct from the leaves, it is to be expected that the histology of the stem would be very simple. It consists, according to Bentley, wholly of parenchyma, with occasionally a central cord of liber cells, but no true vessels.† Sachs, however, says that in mosses with string-like formations in

* 'First Forms of Vegetation,' 2nd ed., p. 22.

† 'Manual of Botany,' p. 91.

the stem, it may appear doubtful whether these are to be considered as peculiar forms of the fundamental tissue, or as very rudimentary fibro-vascular bundles.* Arguing by the great law of evolution, about which these lowly-organised plants teach so much, we should expect to find traces of vessels in mosses, for in the stems of the plants immediately above them—the club-mosses, pepperworts, and horsetails—we find fibro-vascular bundles fully developed.

I have already referred to the fact that mosses are the lowest plants which develope true leaves. These organs are scattered over the stem and branches, and consist wholly of parenchyma. In shape they generally resemble the leaves of the higher plants, and are usually, but not invariably, symmetrical. In some cases they are but microscopical in size, yet, though so small, they are none the less perfect, and have generally a vein which corresponds with the mid-rib of the dicotyledons, of variable length and thickness, which occasionally is continued beyond the tip of the leaf and forms a hair-like point. A very common moss, *Grimmia pulvinata*, which is to be found on nearly all old walls, growing in glaucous-green cushion-like tufts, presents quite a hoary appearance in consequence of these hair-like projections being very strongly developed. Sometimes this hair-point is rough and eroded, as in *Tortula ruralis*. The leaf-margin is often serrated, in some cases it is entire, in others, as in some species of *Mnium*, the border is thickened. In this last-named genus the leaf-cells are very large and loosely placed, and they radiate from the nerve in a very regular and most beautiful manner. The leaf-cells of *Sphagnum* are very interesting objects under the microscope. They are of two kinds, the larger ones containing a spiral thread. The structure of the cells, the presence or absence of one or more nerves, and the shape and margin of the leaf, are very important points to notice in determining a species. These leaves are arranged on the stem and branches in a regular manner, the same law of phyllotaxis being observed which exists in the higher plants. The green colouring is due to the chlorophyll which is present in the cells, but no stomates are believed to occur in the leaves.

Mosses are propagated in several ways, the most ordinary of which is fructification. Like the higher plants, they are either diœcious, monœcious, or polygamous. Instead of effecting fertilisation by means of stamens, pistils, pollen, and ovules, the mosses have other and simpler organs which perform the same functions. These somewhat resemble the antheridia and archegonia of ferns, and are formed in the axils of leafy shoots. After impregnation the sporangium is developed. This is a capsule usually elevated on a footstalk or seta, to allow of the escape of the ripe spores; sometimes, as in several of the *Orthotricha*, water-mosses, etc., it is sessile. Perhaps the reason that no seta is developed in these *Orthotricha* is that they are tree-growing species, and the spores dropping from the capsule are almost certain to fall on the tree trunk in a fit position for germination, and therefore it is not necessary that they should be

* 'Text-book of Botany,' p. 102.

elevated to catch the passing breeze so as to be wafted to a suitable habitat. In the water-mosses of course the non-utility of a seta is evident. The capsule resembles a kind of urn, and usually dehisces by a lid (operculum), which falls off when ripe. Sometimes, however, the lid is absent, and the capsule dehisces by valves, as in the case of the Andreaceæ—mosses which always grow on dry quartzose rocks. The capsule and lid are usually covered by a calyptra or veil, which falls off either before or with the operculum. In the *Polytricha* the veil is hairy, and resembles the cap which Robinson Crusoe is generally represented as wearing; and hence it has acquired the popular name of "Crusoe's Cap." After the lid and calyptra have been removed, a series of beautifully-arranged teeth, called the peristome, is generally revealed. These teeth are hygrometric, and play an important part in the economy of moss life. In wet weather they close over the top of the open capsule, and both prevent the escape of the spores during a period unsuitable for their conveyance from place to place, and also protect them from moisture. When the air becomes drier, they again open out, and allow of the diffusion of the spores. So delicate are these teeth, and so readily affected by humidity, that their movements are easily detected under a low power of the microscope, or with the naked eye. When breathed upon, they close, and as the influence of the moisture of the breath passes away they open out again, often with a spring, jerking the spores out of the capsule. In number, these teeth are either four, or some multiple of four. In some cases, as, for instance, in the order Hypnaceæ, the peristome is found to be double, there being two rows of teeth instead of one. In some instances these teeth are absent, and, when the lid is removed, the mouth of the spore-case is entirely unprotected, while in other cases it is closed by a narrow membrane. In the *Tortulæ* the teeth are beautifully arranged in the form of a long spiral column. This may be distinctly seen in the most common species, *T. muralis*, which may be met with on any wall, for it is the most abundant of our mural mosses.

Besides the usual mode of multiplication by spores, mosses are also propagated by buds, which rise from the roots, and by granules, which are produced either on the midrib, as in *Pottia cavifolia*, on distinct peduncles, as in *Aulacomnium*, or in rosettes, as in *Tetrapis pellucida*. In some cases new plants are even produced at the tips of the leaves. Many of the mosses, too, have a wonderful power of increase by self-extension. As they are, in the main, aerial vegetables, deriving their nutriment partly from the soil, but in a large degree from the air, it is not infrequently that we find the base of a tuft quite dead and decaying, and wrapped in what Ruskin calls "the funeral blackness" of the moss, while the upper part is healthy and green and growing. This is especially the case with the *Sphagnaceæ*, where the plant gets its living principally from the moisture of the bog, the past year's growth decaying and forming nutrient matter for the young shoots of the same plant.

Mosses are easily divisible into two great classes—the Acrocarpi,

or those in which the fruit terminates the stem, and the Pleurocarpi, in which the fruit is apparently lateral, though really placed at the extremity of an arrested branch. These two classes may be compared to the annuals and perennials among flowering plants; the acrocarpous moss simply living to produce its spores, while the pleurocarpous plant goes on growing and fruiting for many years. Besides these two great groups, there are also two other sections—the Amphocarpi and the Cladocarpi—represented in Britain. The class Musci is divided into 34 orders by Mr. Berkeley, one of our best muscologists, to whose work I am indebted for much of the information contained in this paper. His arrangement is, however, being modified and improved upon by Dr. Braithwaite in his exhaustive and beautifully-illustrated 'British Moss Flora,' which is now being issued in parts. This work is a most valuable one, and likely to be our standard Moss Flora for a long time to come.

Before concluding this paper it may not be out of place to allude to the discovery by a member of our Society of a moss new to Britain, although unfortunately that discovery was not made in Hertfordshire. During a visit which he paid to the New Forest in the spring of 1882, Mr. B. Piffard found a moss which he submitted to my friend Mr. Saunders, of Luton, for identification. That gentleman, being unable to determine it, sent it on to Mr. H. Boswell, of Oxford. He immediately wrote that it was *Leucobryum glaucum*, var. *minus*. In July of the same year Mr. Saunders and I went to the Forest, one of our objects being to find out more about the new moss, and we were so successful as to detect it in several places. It is very distinct from *L. glaucum*, being, as the name implies, smaller. It grows under beech-trees principally, on the little sandy hillocks which are of such frequent occurrence in the Forest. I sent specimens to Dr. Braithwaite, and he wrote back, saying that he "was quite unaware that it had been found in this country, or even in Europe," that it did not occur in any of the herbaria he had consulted except as an American plant, and that C. Mueller, the only modern author who mentioned it, gave only American habitats. He proposes to figure it in a supplementary plate at the end of the first volume of his 'Moss Flora.' As the moss was first discovered by Mr. Piffard, one of our members, I think the fact is worthy of record in our 'Transactions.'

Appendix.

List of Hertfordshire Mosses recorded up to 1*st March,* 1884.

In this list I have followed the late Mr. R. A. Pryor's division of the county into six river-districts. No records have been received from the three small districts draining into the Cam, Thame, and Brent. The species recorded in the Ivel district are very few in number, and have, without exception, been sent by Mr. Saunders, of Luton, to whom I am much indebted for the trouble he has taken in looking over and verifying many of the species I have found. My thanks are also due for similar kindnesses to Dr.

Braithwaite, Mr. E. M. Holmes, and Mr. H. Boswell. This list forms the barest outline only of a County Moss-Flora and is given in the hope that more members may be induced to send records.

The Ouse Basin is divided into two sub-districts drained by the Cam and by the Ivel. There are four sub-districts in the Thames Basin, viz. Thame, Colne, Brent, and Lea.

Where no person's name is attached to the locality, it signifies that the moss has been found by myself growing in the spot indicated. The mark sp ! signifies that specimens from the locality named have been seen by me ; while the mark ! after a record means that I, also, have seen the moss growing in the same place. In the nomenclature I have followed the 'London Catalogue of British Mosses.'

I am indebted to the following ladies and gentlemen for communications embodied in this list, their surnames being appended to their records. In most cases specimens were sent for verification.

Mrs. Bishop, The Platts, Watford.
Dr. Braithwaite, F.L.S., 303, Clapham Road, London.
Miss Glover (through Mr. Saunders), Tring.
Mr. E. M. Holmes, F.L.S., Pharmaceutical Society, London.
Mr. John Hopkinson, F.L.S., Wansford House, Watford.
Mr. D. Peirson, Ware Road, Hertford.
Mr. B. Piffard, Hill House, Hemel Hempstead.
Mr. J. Saunders, 47, Rothesay Road, Luton.
Miss Selby, Battlers Green, Aldenham.
Mr. Trevethick (per Mr. Saunders), The Gardens, Putteridge Park.

Section I.—ACROCARPI.

Sphagnaceæ.

Sphagnum subsecundum, Nees. Colne.—Bricket Wood. Berry Grove Wood. Lea.—Colney Heath. Hertford Heath ; *Peirson*, sp ! Var. *contortum*, Schultz. Colne.—Bricket Wood. Var. *obesum*, Wils. Colne.—Bricket Wood. Berry Grove Wood.

S. cymbifolium, Ehrh. Lea.—Little Berkhamsted ; *Coleman*, sp !

Weissiaceæ.

Weissia viridula, Brid. Colne.—Tunnel Woods, Watford ; *Braithwaite*. Near New Barnes. Lea.—Road to Reformatory, Bengeo ; *Peirson*, sp !

W. cirrhata, Hedw. Colne.—No Man's Land. Beech Bottom, Harpenden Road, St. Albans. Radlett. Near Colney Heath Church. On thatch at Hemel Hempstead ; *Saunders*, sp ! Lea.—Gates of Bayfordbury Park, near Hertford ; *Coleman*, sp !

Dicranella varia, Hedw. Colne.—On the ground in a wood at Hemel Hempstead ; *Saunders*, sp ! Tunnel Woods, Watford ! ; *Braithwaite*. Lea.—Panshanger Park ; *Coleman*, sp ! Chalk hills, Caddington ; *Saunders*, sp !

D. heteromalla, Hedw. Colne.—Hedge-bank, Bernard's Heath. Wood, Beaumont's Farm. Bricket Wood. Cassiobury Park. Berry

Grove Wood. Tunnel Woods, Watford. Ashridge; *Saunders*, sp! Lea.—Hertford Heath; *Coleman*, sp! Brocket Park.

Dicranum scoparium, L. Colne.—Bricket Wood. Cassiobury Park. Berry Grove Wood, Aldenham; *Bishop*, sp! Tunnel Woods, Watford. In a fir-wood between Radlett and Letchmore Heath. Lea.—Panshanger Park. Dawley's Wood, Tewin; *Coleman*, sp! Hertford Heath; *Peirson*, sp!

D. palustre, Bry. Brit. Lea.—Hertford Heath; *Coleman*, sp!

Campylopus flexuosus, Brid. Colne.—Berry Grove Wood. Lea.—Dawley's Wood, Tewin; *Coleman*, sp!

Leucobryaceæ.

Leucobryum glaucum, L. Colne.—Berry Grove Wood. Tunnel Woods. Bricket Wood Scrubs. Pools on Scrubs near Munden Schools; *Bishop*, sp! Lea.—Wormley Wood, Hertford; *Coleman*, sp!

Bruchiaceæ.

Pleuridium nitidum, Hedw. Lea.—Field by the river Rib between Ware and Westmill; *Coleman*, sp!

P. subulatum, L. Colne.—Hedgerow, Bernard's Heath. Near Westfields, St. Albans. Lane leading from Dalton's to Verulam Road, St. Albans. Bricket Wood. Berry Grove Wood. Lea.—Bell Wood, Bayford; *Coleman*, sp!

Seligeriaceæ.

Seligeria calcarea, Dicks. Colne.—In a chalk-pit near the old "Copper Mills," Rickmansworth; *Bishop*, sp!

S. subcernua, Schpr. (*S. paucifolia*, Carruth.) Colne.—On chalk nodules in Tunnel Woods, Watford!; *Braithwaite*.

Pottiaceæ.

Phascum cuspidatum, Schreb. Lea.—Hertford; *Coleman*, sp!

Pottia minutula, Schwg. Colne.—Tunnel Woods. Lea.—Field by road to Gallows Plain, Hertford; *Coleman*, sp!

P. truncata, L. Colne.—Lane near Colney Heath Church. Ayer's End, Harpenden. Tunnel Woods, Watford; *Braithwaite*. Hagden Lane gravel-pits, Watford; *Bishop*, sp! Lea.—Broad Oak End, Hertford; *Coleman*, sp!

P. lanceolata, Dicks. Lea.—Bank by the road to Gallows Plain, Hertford; *Coleman*, sp!

Didymodon rubellus, B. & S. Colne.—Gorhambury. Sear's Lane, Harpenden. Hemel Hempstead; *Piffard*, sp! Lea.—Brocket Park.

D. luridus, Hornsch. Colne.—Tunnel Woods, Watford; *Braithwaite*.

Ditrichum flexicaule, Schwg. Colne.—Tring Hills; *Glover*, sp!

Barbula rigida, Schultz. Lea.—Bank by the Hertingfordbury Road, Hertford; *Coleman*, sp!

B. muralis, L. Colne.—Old walls at St. Albans, everywhere. Walls at Watford. Lane's Nursery, Berkhamsted; *Bishop*, sp!

Lea.—Walls at Putteridge; *Saunders*, sp! Chadwell, between Ware and Hertford; *Coleman*, sp!

B. unguiculata, Dill. Colne.—Bricket Wood. Tunnel Woods, Watford. Watford; *Hopkinson*, sp! Lea.—Bank by the road to Gallows Plain, Hertford; *Coleman*, sp!

B. fallax, Hedw. Colne.—L. & N.W.R. bank near Hedges Farm, St. Albans!; *Saunders*. Hedge-row near Radlett. Tunnel Woods, Watford. Hagden Lane gravel-pits, Watford; *Bishop*, sp! Lea.—Wormley Wood, near Hertford; *Coleman*, sp!

B. revoluta, Schwg. Colne.—Walls of Verulam. Watford; *Braithwaite*.

B. convoluta, Hedw. Colne.—Watford; *Braithwaite*. Lea.—Wall by the London Road, Balls Park, Hertford. Wall of All Saints' Churchyard, Hertford; *Coleman*, sp!

B. subulata, L. Colne.—Bank near Colney Heath Church. Temple of Pan Woods, Watford; *Bishop*, sp! Tree-stump, Caddington; *Saunders*, sp! Lea.—Bank of Little Molewood, Hertford; *Coleman*, sp!

B. lævipila, Brid. Lea.—Tree-stump, Caddington; *Saunders*, sp!

B. latifolia, B. & S. Colne.—On trees near Nascott; *Braithwaite*.

B. ruralis, L. Ivel.—Offley; *Saunders*, sp! Colne.—St. Albans. Thatch at Gorhambury. Near Sandridge. On trees near Ayer's End, Harpenden. Near Radlett. Roof of shed, Watford; Thatch at Goldington's Mill, Sarratt; *Bishop*, sp! Lea.—Welwyn. Brocket Park.

B. papillosa, Wils. Colne.—On trees near Nascott; *Braithwaite*.

Ceratodon purpureus, L. Wall at Silk Mills, St. Albans. Wall at Park Street. Lane from Radlett Station to Shenley, not far from railway-bridge. Wall at Battler's Green. Aldenham churchyard. No Man's Land. Ayer's End, Harpenden. Common about Watford; *Bishop*, sp! Lea.—Hertford Heath, *Coleman*, sp!

Calymperaceæ.

Encalypta vulgaris, Hedw. Colne.—Wall of Verulam near Hempstead Road. Lea.—Mead Lane, Hertford; *Coleman*, sp!

Grimmiaceæ.

Grimmia apocarpa, L. Lea.—Great Molewood, near Hertford; *Coleman* (sp. marked ?). Panshanger Park; *Coleman*.

G. pulvinata, Dill. Colne.—Walls at St. Albans and neighbourhood; common. No Man's Land. The Platts House, Watford, *Bishop*, sp! Lea.—Hertingfordbury Road, Hertford; *Coleman*, sp!

G. ovata, W. & M. Lea.—Bank by the road to Hertingfordbury, near Hertford; *Coleman*.

Rhacomitrium canescens, Hedw. Colne.—No Man's Land.

Ulota crispa, Hedw. Lea.—Box Wood, between Hoddesdon and Hertford; *Coleman*.

U. intermedia, Schpr. Colne.—Bricket Wood.

Orthotrichum anomalum, B. & S. Lea.—Bayfordbury Park; *Coleman*.

O. affine, Schrad. Colne.—Trees in Tunnel Woods, Watford. Trees near Harpenden; *Saunders*, sp!

O. diaphanum, Schrad. Lea.—Trees near Union Workhouse, Hertford; *Coleman*, sp!

O. Lyellii, H. & T. Colne.—On Trees, Caddington; *Saunders, recte Boswell.* Ayer's End, Harpenden. Lea.—Brocket Park. Near Digswell Water.

O. leiocarpum, B. & S. Colne.—Trees in Tunnel Woods, Watford; *Braithwaite.* Ayers End, Harpenden. Lea.—Brocket Park.

Funariaceæ.

Physcomitrium pyriforme, L. Colne.—Bank of Ver near Moor Mills. Tunnel Woods, Watford. Broad Oak End, Hertford; *Coleman*, sp!

Funaria hygrometrica, L. Colne.—Wall near the Daltons, St. Albans. Railway bank, Bricket Wood. Cassiobury. Watford; *Hopkinson.* Lea.—Brickfield, Ayott. Panshanger Park; *Coleman*, sp!

Bartramiaceæ.

Bartramia pomiformis, L. Colne.—Near Cell Barnes, St. Albans. Near Westfields, St. Albans. Near Sandridge. Near Colney Heath Church. Banks by Temple of Pan Woods, Watford; *Bishop*, sp! Lea.—Banks of wood by the road from Bengeo to Munden; *Coleman*, sp!

Philonotis fontana, L. Colne.—Colney Heath. Lea.—Bog at Little Berkhamsted; *Coleman*, sp!

Bryaceæ.

Webera nutans, Schreb. Lea.—Bell Wood, Bayford; *Coleman.*

W. carnea, L. Lea.—Panshanger Park; *Coleman.*

Bryum atropurpureum, W. & M. Colne.—Gravel-pits, Watford; *Bishop*, sp.!

B. cæspiticium, L. Colne.—Walls of Verulam. Walls at London Colney. Walls at St. Albans. Tunnel Woods; *Braithwaite.* Old walls at Watford; *Bishop*, sp!

B. argenteum, L. Colne.—Near gas-works, St. Albans. Gravel walks, The Hollies, St. Albans. Tunnel Woods; *Braithwaite.* Watford; *Hopkinson*, sp! Lea.—Gravel-pit by Mead Lane, Hertford; *Coleman.* Roadside between Welwyn and Ayott.

B. capillare, L. Colne.—Beaumont's Wood, St. Albans. Old walls, St Albans. Hedgerow near Radlett. Tunnel Woods, Watford; *Braithwaite.* Temple of Pan banks, Watford; *Bishop*, sp! Lea.—Bell Wood, Bayford; *Coleman*, sp!

B. pseudo-triquetrum, Hedw. Lea.—Hertford Heath; *Coleman*, sp!

B. turbinatum, Hedw. Lea.—Panshanger Park; *Coleman*, sp!

B. roseum, Schreb. Lea.—Bell Wood, Bayford; *Coleman*, sp!

Mniaceæ.

Mnium cuspidatum, Hedw. Lea.—Bayford Wood; *Coleman*, sp!

M. undulatum, Hedw. Colne.—Lane leading from Harpenden Road to Sandridge Road, St. Albans. Gorhambury. Batch Wood.

Sear's Lane, Harpenden. Lovett's Lane, Radlett. Cobden Hollows, Radlett. Berry Grove Wood. Tunnel Woods. Cassiobury Park. Cassiobury wood-walks; *Bishop*, sp! Lea.—Bank of the water-course running from Bayford Wood to the Lea, near Hertford; *Coleman*, sp! Brocket Park. Lilley; *Saunders*, sp!

M. rostratum, Schrad. Colne.—Gorhambury. Batch Wood. Colney Heath. Bricket Wood. Near Moor Mills. Fir-wood near Radlett. Tunnel Woods, Watford. Hill at the back of Boxmoor Station. Lea.—Cold Harbour; *Saunders*, sp!

M. hornum, L. Colne.—Beech Bottom. Batch Wood. Near Westfields, St. Albans. Bricket Wood. Berry Grove Wood. Banks near Aldenham; *Bishop*, sp! Cassiobury Park. Ashridge; *Saunders*, sp! Lea.—Boggy spinney at Bell Bar; *Coleman*, sp! Brocket Park.

M. punctatum, Hedw. Ivel.—Oughton Head; *Saunders*, sp! Colne.—Sear's Lane, Harpenden. Cassiobury Park. Cassiobury wood-walks; *Bishop*, sp! Lea.—Wormley Wood, near Hertford; Bayford Wood; *Coleman*, sp! Edge of pond, Lilley; *Saunders*, sp! Brocket Park.

Aulacomnium androgynum, L. Colne.—Hedgerow near Bernard's Heath, St. Albans. No Man's Land. Hedgerow near Radlett. Lea.—Box Wood, near Hertford; *Coleman*, sp!

A. palustre, L. Colne.—Colney Heath. Bricket Wood Scrubs. Lea.—Hertford Heath; *Coleman*, sp!

Tetraphidaceæ.

Tetraphis pellucida, L. Lea.—Sherrard's Park Wood, Digswell; *Coleman*, sp!

Polytrichaceæ.

Atrichum undulatum, L. Colne.—Harpenden Road, St. Albans. Bricket Wood. Lovett's Lane, Radlett. Berry Grove Wood; *Bishop*, sp! Cassiobury Park. Bank by Temple of Pan Wood, Watford; *Bishop*, sp! Tunnel Woods, Watford. Lea.—Little Berkhamsted; *Coleman*. Road from Welwyn to Ayott. Brocket Park.

Pogonatum nanum, Neck. Colne.—No Man's Land. Bank near Temple of Pan Wood, Watford; *Bishop*, sp! Lea.—Hertford Heath; *Coleman*, sp!

P. aloides, Hedw. Colne.—Lane near Westfields, St. Albans. Bricket Wood. Tunnel Woods, Watford; *Braithwaite*. Watford; *Bishop*, sp! Lea.—Broxbourne Wood, Hertford; *Coleman*, sp!

Polytrichum formosum, Hedw. Colne.—Bricket Wood. Watford; *Hopkinson*, sp! Lea.—Brocket Park. Near Welwyn.

P. piliferum, Schreb. Colne.—No Man's Land. Lea.—Hertford Heath; *Coleman*, sp!

P. juniperinum, Willd. Lea.—Hertford Heath; *Coleman*.

P. commune, L. Colne.—Watford; *Hopkinson*. Sear's Lane, Harpenden. Lea.—Hertford Heath; *Coleman*.

Section II.—AMPHOCARPI.

Fissidentaceæ.

Fissidens bryoides, Hedw. Colne.—Union Lane, St. Albans. Bricket Wood. Radlett. Lovett's Lane, Radlett. Berry Grove Wood. Cassiobury Park. Near Cassiobury Park gates; *Bishop*, sp! Tunnel Woods, Watford. Bennett's End, Hemel Hempstead; *Saunders*, sp! Lea.—Little Berkhamsted; *Coleman*, sp! By the Mimram, near the viaduct, Welwyn Station. Brocket Park.

F. adiantoides, Hedw. Lea.—Hertford Heath; *Coleman*, sp!

F. taxifolius, L. Colne.—Lane near Marshall's Wick, St. Albans. Harpenden Road, St. Albans. Gorhambury. Bricket Wood. Cobden Hollows, Radlett. Wood-walks, Cassiobury; *Bishop*, sp! Tunnel Woods, Watford, Bushey. Chalk downs behind Boxmoor Station. Lea.—Bayford Wood; *Coleman*, sp! Hertford Heath; *Peirson*, sp! Banks of Mimram. By the viaduct, Welwyn Station. Brocket Park.

Section III.—CLADOCARPI.

Ripariaceæ.

Fontinalis antipyretica, L. Ivel.—Oughton Head; *Saunders*, sp! Colne.—Pond near Kendall Hall, Elstree; *Selby*, sp! Brook by Croxley Mills; *Bishop*, sp! Lea.—River Rib, Bengeo; River Lea, near Hertford; *Coleman*, sp. Tewin Water.

Crypheaceæ.

Cryphea heteromalla, Hedw. Lea.—Panshanger Park; *Coleman*, sp!

Section IV.—PLEUROCARPI.

Leucodontaceæ.

Leucodon sciuroides, L. Colne.—Batch Wood. Gorhambury. Wall of Park Bury House, Colney Street. Cassiobury Park. Lea.—On willows under Molewood, Bengeo; *Coleman*, sp! Brocket Park.

Antitrichia curtipendula, L. Colne.—Aldbury Owers Wood; *Coleman*, sp!

Neckeraceæ.

Neckera pumila. Lea.—Panshanger Park. Bayfordbury Park; *Coleman*, sp!

N. crispa, L. Colne.—Wood west of Tring; *Coleman*, sp! (? Herts).

N. complanata, L. Colne.—Beaumont's Farm, St. Albans. Gorhambury. Batch Wood. Between Sandridge and Coleman Green. No Man's Land. Sear's Lane, Harpenden. Near Radlett. Tunnel Woods, Watford. Tring Woods; *Glover*, sp! Lea.—Mangrove Lane, Hertford; *Peirson*, sp! Panshanger Park; *Coleman*, sp! Brocket Park.

Homalia trichomanoides, Schreb. Colne.—Near Marshall's Wick, St. Albans. Gorhambury. Batch Wood. Bricket Wood. Tunnel Woods. Lea.—Copse between Little Berkhamsted and Hertford; *Coleman*, sp!

LESKEACEÆ.

Leskea polycarpa, Ehrh. LEA. — Great Molewood, Bengeo; *Coleman*, sp!

Anomodon viticulosus, L. COLNE.—Walls of Verulam. Gorhambury. Batch Wood. Sandridge. Near Colney Street. Lovett's Lane, Radlett. Tunnel Woods, Watford. Tring Woods; *Glover*, sp! LEA.—Mangrove Lane, Hertford; *Peirson*, sp! Dawley's Wood, Tewin; *Coleman*, sp! Brocket Park.

Thuidium tamariscinum, Hedw. COLNE.—Beaumont's Wood, St. Albans. Sear's Lane, Harpenden. Bricket Wood!; *Selby*; *Bishop*. Berry Grove Wood!; *Bishop*. Lane from Radlett to Boreham Wood. Cassiobury Park. LEA.—Hertford Heath; *Peirson*, sp! Brocket Park.

T. abietinum, L. LEA.—Panshanger Park; *Coleman*, sp!

HYPNACEÆ.

Thamnium alopecurum, L. COLNE.—Beaumont's Wood, St. Albans. Verulam Woods. Gorhambury. Batch Wood. Sear's Lane, Harpenden. Near Radlett. Tunnel Woods, Watford. Tring, Woods; *Glover*, sp! LEA.—Bayford Wood; Wormley Wood; *Coleman*, sp! Mangrove Lane, Hertford; *Peirson*, sp!

Climacium dendroides, L. IVEL.—Oughton Head; *Saunders*, sp! COLNE.—By the Ver, near Moor Mills. Bricket Wood Scrubs. LEA.—Ditch-bank in meads between Ware and Hertford. Panshanger Park; *Coleman*, sp!

Isothecium myurum, Poll. COLNE.—Near Sandridge. On tree-stump near Harpenden; *Saunders*, sp! Batch Wood. Bricket Wood. Berry Grove Wood; *Bishop*, sp! Ashridge; *Saunders*, sp! LEA.—Boxwood, near Hertford Heath; *Coleman*, sp!

Homalothecium sericeum, L. COLNE. — On trees, Ayers End, Harpenden. Walls, Verulam Road, St. Albans. Roman wall, Gorhambury Road. Walls at St. Julians, Park Street, and Colney Street. Tunnel Woods; *Braithwaite*. Gravel-pits, Hagden Lane, Watford; *Bishop*, sp! LEA.—Putteridge; *Saunders*, sp! (? Ivel). Hertingfordbury; *Peirson*, sp! Panshanger; *Coleman*, sp! On trees by the Mimram, near Welwyn Station. Welwyn. Brocket Park. Lilley; *Saunders*, sp!

Camptothecium lutescens, Huds. COLNE.—Near Sandridge. Harpenden Road, St. Albans, on bank near the road to Sandridgebury. Gorhambury. Batch Woods. Tunnel Wood. Rough Down; *Saunders*, sp! LEA.—Panshanger Park; chalk-pit at Little Munden; *Coleman*.

Brachythecium glareosum, B. & S. COLNE. — Near Sandridge. Tunnel Woods. Ashridge; *Saunders*, sp!

B. albicans, Neck. IVEL.—On thatch at Offley; *Saunders*, sp! COLNE.—Under fir-trees opposite Hawkswick, St. Albans. LEA.—Box Wood, between Hoddesdon and Hertford; *Coleman*, sp!

B. velutinum, L COLNE.—Verulam Woods, St. Albans. Workhouse Lane, St. Albans. Near Sandridge. Berry Grove Wood; *Bishop*, sp! Cassiobury Park. Tunnel Woods; *Braithwaite*.

Watford; *Hopkinson*, sp! Lea.—Hertford Heath; *Peirson*, sp! Box Wood, between Hoddesdon and Hertford; *Coleman*, sp! Brocket Park.

B. rutabulum, L. Colne.—Sear's Lane, Harpenden. Near Marshall's Wick, St. Albans. Beech Bottom. Harpenden Road, St. Albans. Verulam Woods. Gorhambury. Walls of Verulam. Blue House Hill, St. Albans. Bricket Wood. Lovett's Lane, Radlett. Cassiobury Park. Tunnel Woods. Berry Grove Wood; on old walls, Watford; Rickmansworth Road, Watford; gravel-pits, Watford; *Bishop*, sp! Cold Harbour; *Saunders*, sp! Panshanger Park; *Coleman*, sp! Hertford Heath; wood near Presdales, Ware; wood by Hertford Workhouse; lane by Stanstead Road; *Peirson*, sp! Road from Welwyn to the station. Bank of Mimram near G.N. viaduct, Welwyn. Brocket Park.

B. plumosum, Swartz. Lea.—Plantation near Hertford Workhouse; *Coleman*, sp!

Eurhynchium striatum, Schreb. Colne.—Lane leading from Harpenden Road to Sandridge Road, St. Albans. Sear's Lane, Harpenden. Gorhambury. Park Street. Colney Street. Bricket Wood; *Bishop*, sp! Berry Grove Wood. Cobden Hollows, Radlett. Lane from Radlett to Boreham Wood. Lovett's Lane, Radlett. Markyate Street; *Saunders*, sp! Banks by Temple of Pan Woods; The Grove, Watford; *Bishop*, sp! Lea.—Box Wood, between Hoddesdon and Hertford; *Coleman*, sp! Bank on Welwyn Road, Ayott.

E. crassinervium, Tayl. Colne.—Walls of Verulam. Gorhambury. Hoo Wood, Gaddesden; *Piffard*, sp!

E. piliferum, Schreb. Colne.—Near the gas-works, St. Albans. Near Radlett. Tunnel Woods, Watford. Lea. — Caddington; *Saunders*, sp! Panshanger Park; *Coleman*, sp! Hertford Heath; *Coleman* and *Peirson*, sps! Stanstead Road, Hertford. Near Hertford Workhouse; *Peirson*, sp!

E. Swartzii, Turn. Colne.—Woods, Verulam Hills, St. Albans. Markyate Street; *Saunders*, sp! Tunnel Woods, Watford. Lea.—Roadside between Welwyn and Ayott.

E. prælongum, Dill. Colne.—Marshall's Wick, St. Albans. Beaumont's Farm, St. Albans. Fir plantation, Harpenden Road. Blue House Hill. Verulam Woods. Gorhambury. Lovett's Lane, Radlett. Lane from Radlett to Shenley. Near Radlett Village. Watford; *Bishop*, sp! Tunnel Woods, Watford. Cassiobury Park. Lea.—Lilley; *Saunders*, sp! Panshanger Park; *Coleman*, sp! By Hertford Union; Hertford Heath; wood near Presdales, Ware; *Peirson*, sp! Near Welwyn. Brocket Park.

E. pumilum, Wils. Colne. — Gorhambury. Tunnel Woods; *Braithwaite*.

Rhynchostegium confertum, Dicks. Colne.—On trees, Sear's Lane, Harpenden. Tunnel Woods; *Braithwaite*. Lea. — Park-wall, Puckeridge; *Saunders*, sp! Panshanger Park; *Coleman*, sp!

R. ruscifolium, Neck. Colne.—Footbridge near New Barnes Mill, St. Albans. The waterfall, and on stones in the Gade,

Cassiobury Park; the floodgates, The Rookery, Watford; *Bishop*, sp! Mill-wheel, Boxmoor; *Saunders*, sp! Lea.—Wheathampstead Mill. River-side between Ware and Hertford; *Coleman*, sp!

Plagiothecium denticulatum, var. *sulcatum*, Spruce. Colne.—Workhouse Lane, St. Albans. Lane from The Daltons to Verulam Road, St. Albans. Sear's Lane, Harpenden. Gorhambury. Markyate Street; *Saunders*, sp! Bricket Wood. Berry Grove Wood. Lovett's Lane, Radlett. Tunnel Woods, Watford. Ashridge; *Saunders*, sp! Lea. — Bell Wood, Bayford; *Coleman*, sp! Hertford Heath; *Peirson*, sp! Banks of Mimram, near Welwyn viaduct.

P. undulatum, L. Lea. — Sherrard's Park Wood, Digswell; *Coleman*, sp!

Amblystegium serpens, L. Colne.—Gorhambury. Tunnel Woods, Watford; *Hopkinson*, sp! Lea.—Panshanger Park; *Coleman*, sp! By River Mimram, near Welwyn viaduct. Brocket Park.

A. riparium, L. Pondyards, Gorhambury. Brook near Radlett. Pond, Bennett's End; *Saunders*, sp! Lea. — Riverside between Ware and Hertford; *Coleman*, sp!

Hypnum aduncum, Hedw. Colne.—Bricket Wood Scrubs. Boxmoor; *Saunders*. Lea. — Pond by Mangrove Lane, Hertford; *Coleman*, sp!

H. fluitans, L. Ivel.—Oughton Head; *Saunders*, sp! Colne.—Wet meadows near Moor Mills. Bricket Wood Scrubs. Lea.—Wet meadow near Great Northern Station, Harpenden; *Saunders*, sp!

H. filicinum, L. Colne.—The Old Mill, Cassiobury. Boxmoor; *Saunders*, sp! Lea.—Riverside between Ware and Hertford; *Coleman*, sp! "Also var. *fallax*"; *Coleman*.

H. commutatum, Hedw. Colne.—Water End; *Piffard*, sp! Lea.—Lilley; *Trevethick*, sp!

H. cupressiforme, L. Colne.—Roof of shed at Bramblewood Farm, Harpenden. Sear's Lane, Harpenden. Near Marshall's Wick, St. Albans. Walls of Verulam near Hempstead Road. Roof of cottage, Gorhambury Park. Bricket Wood. Berry Grove Wood. Lovett's Lane, Radlett. Tunnel Woods. Cassiobury Park. Gravel-pits, Watford; Temple of Pan Woods, Watford; *Bishop*, sp! Lea.—Hertingfordbury; *Coleman*, sp! Panshanger Park, "var. *tenue*"; *Coleman*. Hertford Heath; *Peirson*, sp! By the Mimram, near Welwyn viaduct. Brocket Park.

H. resupinatum, Wils. Lea.—Lilley; *Trevethick*, sp!

H. chrysophyllum, Brid. Colne.—Near Sandridge. Gorhambury. Rough Down, Boxmoor; *Saunders*, sp!

H. stellatum, Schreb. Colne. — Bog at Little Berkhamsted, *Coleman*, sp!

H. cordifolium, Hedw. Lea.—Pond near Wormley West End. Pond in Bayford Wood. Pond at Broxbournebury; *Coleman*, sp!

H. cuspidatum, L. Colne.—Bog at Bell Bar; *Coleman*, sp! Beaumont's Farm, St. Albans. Gorhambury. Lane from Radlett to Boreham Wood. Cobden Hollows, Radlett. Tunnel Woods. Marsh at Cassio Bridge; *Bishop*, sp! Chalk hills behind Boxmoor Station. Lea.—Riverside between Wheathampstead and Cold Har-

bour. By the Mimram near Welwyn viaduct. Road from Welwyn to Ayott. Brocket Park.

H. Schreberi, Ehrh. Lea.—Hertford Heath; *Coleman*, sp!

H. purum, L. Colne.—Harpenden Road, St. Albans. Workhouse Lane, St. Albans. Gorhambury. Colney Street. Fir-wood between Radlett and Battler's Green. Lane from Radlett to Boreham Wood. Cobden Hollows, Radlett. Tunnel Woods. Temple of Pan Woods, Watford; *Bishop*, sp! Chalk hills near Boxmoor. Lea.—Box Wood, between Hertford and Hoddesdon; *Coleman*, sp! Road from Welwyn to Ayott. Brocket Park.

H. stramineum, Dicks. Lea.—Hertford Heath; *Coleman*, sp!

Hylocomium splendens, Dill. Colne.—Workhouse Lane, St. Albans. Gorhambury. Bricket Wood. Chalk hills behind Boxmoor Station. Ashridge; *Saunders*, sp! Lea.—Hertford Heath; *Peirson*, sp! Panshanger Park; *Coleman*, sp!

H. brevirostrum, Ehrh. Colne.—Bricket Wood!; *Bishop*. Hoo Wood, Gaddesden; *Piffard*, sp! Lea.—Dawley's Wood, Tewin; *Coleman*, sp!

H. squarrosum, L. Colne. — Gorhambury Woods. Bricket Wood. Cobden Hollows, Radlett. Tunnel Woods. Cassiobury Park and woods; *Bishop*, sp! Lea.—Box Wood, between Hertford and Hoddesdon; *Coleman*, sp! Hertford Heath; *Peirson*, sp! Side of Welwyn Road, Ayott.

H. loreum, L. Colne.—Hoo Wood, Gaddesden; *Piffard*, sp! Grove Wood, Tring; *Coleman*, sp!

H. triquetrum, L. Colne.—Beaumont's Wood, St. Albans, Batch Wood. Gorhambury Woods. Bricket Wood. Berry Grove Wood. Tunnel Woods. Near Bourne End. Lea.—Box Wood, between Hertford and Hoddesdon; *Coleman*, sp!

IX.

NOTES ON BIRDS OBSERVED IN HERTFORDSHIRE DURING THE YEAR 1883.

By John E. Littleboy.

Read at Watford, 18th March, 1884.

I have now the pleasure to lay before our members, I think for the fifth time, a few notes respecting birds observed in Hertfordshire during a preceding year.

Only four additional species—the twite, the hoopoe, the hen-harrier, and the dotterel—have been reported since the reading of my last paper. It will be readily understood that as year succeeds to year the difficulty of adding new species to our register is greatly increased, and it is with considerable satisfaction that I am able to announce the number I have already stated. The four birds that I have just named will increase the number on our register to 154 species. I will at once proceed to record a few particulars respecting them.

1. The Twite (*Linota flavirostris*).—A pair of twites were caught in bird-nets during the month of December, near the village of Aldbury, at the foot of the Chilterns. They were exhibited for some time at Mr. Banfield's, bird-dealer, Hemel Hempstead.

The twite and the linnet are closely congeneric birds, the former taking the place of the latter in the wilder or more mountainous districts of these islands. When observed at large there is but little by which to distinguish the one species from the other, but those who are acquainted with the song of the linnet will readily distinguish the twite from that bird by its shriller call-note. It is also more slender and elegant than the linnet. It is a spring and autumn visitor to Great Britain, and frequently remains with us during the winter when the season is mild and favourable.

2. The Hoopoe (*Upupa Epops*).—A hoopoe, in fine plumage, was shot by Samuel Gooch, one of the keepers on the Brocket Hall estate, near Digswell, in the parish of Welwyn, in May, 1882. It is still in his possession. I am indebted for this important information to Mr. J. Sharp, Dagnal Street, St. Albans, a genuine lover of birds, who has kindly supplied me, from time to time, with many valuable notes.

The hoopoe is an irregular spring and autumn migrant. Several specimens have, at different times, been taken in Hertfordshire, but always at considerable intervals. The striking appearance of the hoopoe renders it a ready mark for the aim alike of gamekeeper and sportsman, and I think it may be said that no British bird, without even excepting the brilliant golden oreole, is more ruthlessly persecuted to death than the beautiful hoopoe. "With all its natural dignity and beauty," writes Yarrell,* "the hoopoe possesses some very unpleasant peculiarities, and these are intensified during the breeding season. The bird generally seeks its living amid the most obscene refuse. Beetles of many

* 'British Birds,' 4th edition, vol. ii, p. 423.

kinds and in every stage, as well as caterpillars, are eaten, and the hen, it would appear, scarcely ever leaves the nest for the sixteen days of her incubation." Occasional instances of the nesting of the hoopoe in England are recorded, apparently on good authority. The veteran naturalist, Gilbert White, thus refers to the subject in his delightful 'Natural History of Selborne.'* "The most unusual birds I have ever observed in these parts were a pair of hoopoes which came several years ago in the summer and frequented an ornamental piece of ground, which joins to my garden, for several weeks. They used to march about in a stately manner, feeding in the walks many times a day, and seemed disposed to breed in my outlet, but were frightened and persecuted by idle boys."

3. The Hen-Harrier (*Circus cyaneus*).—A ringtail, or female hen-harrier, was observed by Mr. Marlborough R. Pryor at Weston Manor, near Stevenage, on the 28th of October, and on one or two subsequent occasions. When only seen upon the wing, it is very difficult to distinguish a female hen-harrier from the female of Montagu's harrier. Mr. Pryor had a good opportunity of observing the bird in question; he is well acquainted with both species; he believes, both from its general appearance, and from the period of the year at which it was seen, that it was a hen-harrier, and as such I accept it.

The hen-harrier is one of the more rare among our British Raptores. Like most of its fellows it is gradually becoming scarcer, and at present is but rarely known to breed within the limits of the three kingdoms. "It was formerly a regular summer visitor to the British Islands; it is now principally seen on its autumnal migration."† Male and female harriers differ very considerably in appearance, and for many years were supposed to belong to different species. The question was satisfactorily settled by Montagu,‡ who reared three young birds from the nest, and found, by careful observation, that the distinctive plumage of the male bird is only assumed "in the autumn of the year after it leaves its nest, and not in the same year." The name, hen-harrier, is said to have originated from certain predatory proclivities which this species is supposed to exhibit, not only towards game on mountain-side and moor, but, whenever opportunity offers, towards the domestic poultry of the farm-yard. Respecting the hen-harrier, Mr. Henry Seebohm writes as follows: § "A more appropriate name would be the 'mountain-harrier.' It is very partial to hill-sides, hunting them systematically, with great perseverance, like a pointer, returning backwards and forwards over the same ground. I have never seen them soar very high: they fly remarkably steadily, with slow regular beats of the wing, like a heron, turning sharply with a twist of the tail like a kite, now and then hovering like a kestrel, and anon skimming over the ground like a grouse."

* Edition 1788, p. 34.
† Seebohm's 'British Birds,' vol. i, p. 128.
‡ 'Ornithological Dictionary,' Ed. 1833, p. 250.
§ 'British Birds,' vol. i. p. 129.

4. The Dotterel (*Eudromias Morinellus*).—On the 28th and 29th of August two large flocks of dotterels are reported by Mr. Percy F. Fordham as having been observed on Royston Heath; and on September 24th a single specimen, believed to be a bird of the year, was shot in turnips near Weston Manor, Stevenage, by Mr. Marlborough R. Pryor.

The dotterel is a spring and autumn migrant. It is said to nest occasionally in Scotland and the north of England, but its natural home is on the grassy hills and open prairies of northern Europe, and it visits our shores for a short period only during its northern and southern migration to and from those localities. Belonging to the family of Plovers, the dotterel, like some others of its tribe, has a habit of stretching out its wings alternately. From this action, and the fact that it allows the approach of man with but little apparent fear, it has gained its designation *Morinellus*, or "little fool." In olden times it was frequently the victim of falconry, and it is stated* that the 10th of May was specially devoted to that sport, and was known on the borders of Hertfordshire and Cambridgeshire as "Dotterel's day." It is interesting to notice that dotterels are still observed in the same district in which they are reported as being abundant during the reign of James the First.

The dates on which the arrival and departure of our summer migrants and other visitants have been reported, together with the names of the observers, will be found in the following tables:—

Summer Migrants.

Species.	Locality.	Date.	Observer.
Nightingale ... ... (*Daulias Luscinia*)	Royston	April 14	G. W. Howard.
	Hitchin	,, 18	W. Hill, jun.
	Hertford	,, 18	R. T. Andrews.
	Hailey Hall	,, 18	H. C. Heard.
	Odsey Grange ...	,, 18	H. G. Fordham.
	Elstree	,, 18	E.P.Thompson.
	Harpenden	,, 19	John J. Willis.
	Royston	,, 20	A. Kingston.
	,, ...	,, 21	P. F. Fordham.
	Berkhamsted	,, 22	Herts N.H.S.
	Watford	,, 22	J. Hopkinson.
	Fanhams Hall ...	,, 26	R. B. Croft.
Redstart ... ... (*Ruticilla Phœnicurus*)	Hitchin	May 3	Hitchin Nat. Hist. Club.
	Royston	,, 10	P. F. Fordham.
Chiffchaff ... ... (*Phylloscopus collybita*)	Hitchin	April 4	W. Hill, jun.
	Royston	,, 16	P. F. Fordham.
	Hunton Bridge ...	,, 23	J. E. L.
	Odsey Grange ...	,, 30	H. G. Fordham.
Willow Wren .. .. (*Phylloscopus Trochilus*)	Hitchin	,, 4	Hitchin H.N.C.
	,, ...	,, 8	W. Hill, jun.
	Hunton Bridge ...	,, 21	J. E. L.
	King's Langley ...	,, 22	J. E. L.
	Watford	,, 22	J. Hopkinson.
	Odsey Grange ...	,, 29	H. G. Fordham.

* Hone's 'Everyday Book,' 1826, p. 645.

Species.	Locality.	Date.	Observer.
Whitethroat ... ... (*Sylvia rufa*)	King's Langley ...	April 22	J. E. L.
	Elstree	,, 29	E.P.Thompson.
Lesser Whitethroat ... (*Sylvia Curruca*)	Bourne End	,, 29	J. E. L.
	Royston...	May 17	P. F. Fordham.
Garden Warbler ... ... (*Sylvia salicaria*)	Odsey Grange ...	April 29	H. G. Fordham.
Blackcap ... ... (*Sylvia Atricapilla*)	Odsey Grange ...	Mar. 15	H. G. Fordham.
	Royston...	May 14	P. F. Fordham.
Sedge Warbler ... ... (*Calamodus schœnobœnus*)	Hunton Bridge ...	April 23	J. E. L.
	Hitchin	,, 29	W. Hill, jun.
Spotted Flycatcher ... (*Muscicapa grisola*)	Hunton Bridge ...	,, 25	J. E. L.
	Hitchin	May 6	Hitchin N.H.C.
	Odsey Grange ...	,, 8	H. G. Fordham.
	Royston...	,, 23	P. F. Fordham.
Pied Wagtail ... ... (*Motacilla lugubris*)	Rickmansworth ...	Mar. 11	H. Procter.
	Chipperfield Common	,, 23	J. E. L.
Swallow ... ... (*Hirundo rustica*)	Hertford	April 1	R. W. Brett.
	Croxley Mills ...	,, 7	F. G. Lloyd.
	Rickmansworth ...	,, 10	H. Procter.
	Bushey Mill	,, 12	Dr. A. T. Brett.
	Hunton Bridge ...	,, 14	J. E. L.
	Ashwell...	,, 14	E. S. Fordham.
	Royston...	,, 14	E. O. Fordham.
	Gammon's Farm ...	,, 15	Miss E. Rooper.
	Watford	,, 15	J. Hopkinson.
	Hemel Hempstead	,, 16	W. Mason.
	Hitchin	,, 16	W. Hill, jun.
	Royston...	,, 16	A. Kingston.
	Hertford	,, 16	R. T. Andrews.
	Hailey Hall	,, 16	H. C. Heard.
	Barnet	,, 17	E. R. Raitt.
	Fanhams Hall ...	,, 19	R. B. Croft.
	Elstree	,, 22	E.P.Thompson.
	Harpenden	,, 28	John J. Willis.
	Odsey Grange ...	,, 28	H. G. Fordham.
(Last seen)	,, ...	Oct. 13	,,
,, ...	Hitchin	Nov. 7	W. Hill, jun.
House Martin ... ... (*Chelidon urbica*)	Harpenden	April 14	John J. Willis.
	Hitchin	,, 18	W. Hill, jun.
	Royston...	,, 22	P. F. Fordham.
	Fanhams Hall ...	May 3	R. B. Croft.
(Last seen)	Stevenage	Nov. 12	M. R. Pryor.
Sand Martin ... ... (*Cotyle riparia*)	Hitchin	April 18	W. Hill, jun.
	Fanhams Hall ...	May 2	R. B. Croft.
Wryneck ... ... (*Yunx Torquilla*)	Hitchin	April 8	W. Hill, jun.
Cuckoo ... ... (*Cuculus canorus*)	Royston	,, 14	P. F. Fordham.
	Elstree	,, 14	E.P.Thompson.
	Hailey Hall ...	,, 15	H. C. Heard.
	Hadley Woods ...	,, 16	E. R. Raitt.
	Watford	,, 16	J. Hopkinson.
	Harpenden	,, 18	John J. Willis.
	Ashwell...	,, 18	E. S. Fordham.
	Fanhams Hall ...	,, 19	R. B. Croft.
	Hailey Hall	,, 19	H. C. Heard.
	Royston...	,, 20	W. Kingston.
	Nascott Woods ...	,, 22	Miss E. Rooper.
	Hertford	,, 23	R. T. Andrews.
	Cassiobury	,, 24	Dr. A. T. Brett.
	Hitchin	,, 24	W. Hill, jun.

Species.	Locality.	Date.	Observer.
Swift	Hitchin	May 1	Hitchin N.H.C.
(*Cypselus Apus*)	Harpenden	,, 3	John J. Willis.
	Hitchin	,, 7	W. Hill, jun.
	Fanhams Hall ...	,, 8	R. B. Croft.
	Hunton Bridge ...	,, 9	J. E. L.
	Ashwell	,, 12	E. S. Fordham.
	Odsey Grange ...	,, 19	H. G. Fordham.
(Last seen)	,, ...	Aug. 20	,,
,, ...	Hitchin	Sept. 11	W. Hill, jun.
,, ...	Royston	,, 9	S. H. Fordham.
,, ...	Hitchin	,, 19	Hitchin N.H.C.
Turtle Dove	Royston	April 20	P. F. Fordham.
(*Turtur auritus*)	Odsey Grange ...	May 4	H. G. Fordham.
	Hitchin	,, 13	Hitchin N.H.C.
Stone Curlew	Royston	,, 13	P. F. Fordham.
(*Œdicnemus Scolopax*)	,, ...	,, 17	W. Norman.
(Last seen)	,, ...	Sept. 12	P. F. Fordham.
Corn Crake	Hailey Hall	May 3	H. C. Heard.
(*Crex pratensis*)	Odsey Grange ...	,, 9	H. G. Fordham.
	Elstree	,, 14	E. P. Thompson.
	Watford	,, 15	Mrs. Littleboy.
	Fanhams Hall ...	,, 15	R. B. Croft.

Spring, Autumn, and Winter Visitants.

Redwing	King's Langley ...	Nov. 28	J. E. L.
(*Turdus iliacus*)			
Fieldfare	Watford Tunnel ...	Oct. 25	Mr. Rooper's keeper.
(*Turdus pilaris*)	Hunton Bridge ...	Nov. 10	F. Warren.
	Odsey Grange ...	,, 14	H. G. Fordham.
Ring Ouzel	Near Royston ...	Sept. 12	W. Norman.
(*Turdus torquatus*)	Therfield	Oct. 13	J. Bowman.
	Near Ware	,, 17	Norman Thrale.
	Hertford	Nov. 25	R. W. Brett.
Great Gray Shrike ...	Hertford	Dec. 16	R. W. Brett.
(*Lanius Excubitor*)	Weston Manor ...	,, 26	M. R. Pryor.
Lesser Redpoll	Hemel Hempstead	Oct. 1	J. Banfield.
(*Linota rufescens*)			
Hooded Crow	Hertford	Mar. 10	R. W. Brett.
(*Corvus Cornix*)	Odsey Grange ...	,, 26	H. G. Fordham.
	Sandon	,, 29	E. O. Fordham.
	Weston Manor ...	Oct. 29	M. R. Pryor.
	Sandon	Nov. 2	E. O. Fordham.
	Odsey Grange ...	,, 7	H. G. Fordham.
Short-eared Owl	Hunton Bridge ...	Jan. 18	J. E. L.
(*Asio accipitrinus*)			
Woodcock	Odsey Grange ...	Oct. 16	H. G. Fordham.
(*Scolopax Rusticola*)	Royston	Nov. 13	P. F. Fordham.
	Therfield	,, 23	H. G. Fordham.

Miscellaneous Notes.

Redstart (*Ruticilla Phœnicurus*).—A pair of redstarts frequented Mr. A. Cottam's garden, Essex Road, Watford, during the early summer.

Redbreast (*Erithacus Rubecula*).—Mr. Thrale, of Port Vale, Hertford, reports that he watched, during the month of July, a pair of robins carefully feeding a young cuckoo which had been hatched by them in an old willow-tree.

Great Gray Shrike (*Lanius Excubitor*).—A great gray shrike is reported, by Mr. R. W. Brett, as shot on the 16th of December in the neighbourhood of Hertford. A second was observed by Mr. Marlborough R. Pryor, on the 26th of December, flying off with a shrew-mouse in its claws. It will be noticed that I have been able to report one or two occurrences of this comparatively rare bird during three consecutive years. It may fairly be considered as a regular winter visitor to Hertfordshire.

The Wagtails (*Motacilla lugubris* and *M. sulphurea*).—The gray wagtail, *M. sulphurea*, was tolerably abundant in October, but became much scarcer as the year advanced. It is a regular winter visitant in Herts, and may generally be met with in this neighbourhood from October to March, both inclusive. The pied-wagtail, *M. lugubris*, left us as usual in October, but returned very early in the present year. I think it will be found that although the pied-wagtail leaves our valleys regularly in the autumn, it is only a semi-migrant. I am informed by several farmers that it is to be seen, throughout the winter, on turnip-lands or wherever sheep are folded. Mr. Cordeaux* remarks that "the increased cultivation of turnips in Lincolnshire has induced this species to become a winter resident there, which it formerly was not, the roots of those vegetables sheltering the eggs or larvæ of insects, which it picks out." It is probable that the same reason will account for its tarriance during the winter in our own county. Both species may frequently be seen wading on the borders of streams, and it is said that they are expert fishers.

Goldfinch (*Carduelis elegans*).—Mr. A. E. Gibbs writes to me that on the 18th of January an unusually large flight of these beautiful little birds was observed on Bernard's Heath. Several were taken and mounted.

Lesser Redpoll (*Linota rufescens*).—The usual autumnal flight of redpolls passed over our district early in October, but very few have since been met with.

Tree-Sparrow (*Passer montanus*).—On the 15th of November, and on one or two previous days, I was fortunate in identifying a few tree-sparrows on the alders near the stream at Hunton Bridge. It is extremely likely that they may have visited us on many previous occasions; but this is the first time I have been able positively to recognise them.

Greater Spotted Woodpecker (*Picus major*).—A specimen of this species was shot by Mr. Stannard on the 12th of January in Hazelwood Park. A second was observed in December by Mr. H. Procter, near Berkhamsted.

Skylark (*Alauda arvensis*).—Skylarks are reported from all parts of the county as having commenced to sing from the beginning to the middle of January. A peculiar variety, almost yellow in colour, was observed both by Miss Selby and by Mr. Bright's keeper, during the summer, in the neighbourhood of Aldenham.

* Yarrell's 'British Birds,' 4th edition, vol. i, p. 543.

It flew about with the rest, and, with the exception of its colour, was in all respects similar in appearance to its fellows.

Kingfisher (*Alcedo Ispida*).—I am glad to be able to report that these brilliant-plumaged birds have been very plentiful on this side of the county during the year. At Hunton Bridge we have seen them almost daily, and have constantly watched them diving into the stream after small fish. It is noticeable that they almost always kill their victims by rapping them on the rail or stone on which they alight, before eating them.

Long-eared Owl (*Asio Otus*).—Mr. Percy F. Fordham reports the finding of two nests of these interesting birds near Royston; the first on July 12th, with two young owlets; the second on July 23rd, with three eggs. Both were built in branches of the spruce-fir, the one in a deserted hawk's nest, the other in the nest of a wood-pigeon. It has often been asserted that the long-eared owl rarely or never builds its own nest; these two instances appear to corroborate the statement.

Whimbrel (*Numenius Phæopus*).—I am pleased again to record the occurrence of a whimbrel within the limits of our county. Mr. W. Norman, of Royston, reports having obtained a specimen shot at Buckland. The whimbrel has only once before been reported.

Woodcock (*Scolopax Rusticola*).—Woodcocks have been tolerably plentiful on this side of the county, and several are reported as having been shot in the Royston and Therfield districts.

Golden Plover (*Charadrius pluvialis*).—Large numbers of the golden plover have visited us during the past year. In March they are reported by Mr. H. G. Fordham as abundant near Odsey. A few are reported as observed in the same district, and also near Hertford, early in September; but from that date to the commencement of the east winds which preceded the snow in December, they were, to use the words of Mr. H. C. Heard, "remarkable by their absence." In December they became very abundant. Large flocks are reported by Mr. Heard on the 6th and 9th, and on the 14th and 29th "immense flocks" are again mentioned. On the latter occasion they were extremely tame, and several were shot within a distance of thirty yards.

Dabchick (*Podiceps minor*).—Mr. N. Thrale, of Port Vale, Hertford, has forwarded to me a note respecting the choking of dabchicks which is, I think, worthy of record. "In November," writes Mr. Thrale, "I was walking by the river Beane at Waterford Marsh, near Bengeo, when I noticed a bird floating on its back in the water. It proved to be a dabchick with rather a large bull-head in its throat, partly swallowed. The fish was full of spawn, and the dabchick could neither swallow nor eject it. About three weeks later a young gentleman found a second dabchick, which had been choked in a similar manner, but in this instance the bull-head was very nearly swallowed. It had floated down the Beane and lodged against some river-gates. To-day (February 15th, 1884) I found in the river Beane, but rather nearer Hertford, a

third dabchick choked, just as in the two former instances, by attempting to swallow a bull-head."

Pochard (*Fuligula ferina*).—I am informed by Mr. Marlborough R. Pryor that a pochard was shot on the 20th of June on the pond at Weston Manor, near Stevenage.

Puffin (*Fratercula arctica*).—During the year 1882 I was able to report the occurrence of three puffins, all of which were taken on the northern side of our county. I have again to record the finding of a puffin in the same neighbourhood. It was picked up at Reed, near Royston, and appeared to have been injured by flying against telegraph wires. It is reported by Mr. William Norman of Royston.

White Stork (*Ciconia alba*).—A white stork was shot somewhere about the end of July, while resting on the top of a house near Hatfield. It seems more than probable that it was one of two, reported in the 'Field,' Nov. 28th, 1882, to have escaped from Chequers Court, near Tring, the residence of Mr. H. D. Astley. Under these circumstances I cannot legitimately include it among the birds of Hertfordshire.

The stork is one of the best known and most regular of all migratory birds; it is extremely scarce in the British Isles, and can only be considered a rare and accidental visitor. In Holland, where it is treated with almost superstitious attention, it is common during the summer months. Anecdotes respecting the fondness of the stork for her young, and the care with which she protects them from danger or injury, abound both in ancient and modern literature.

Curious Nesting Places.—Dr. A. T. Brett has forwarded some interesting reports of eccentric nesting. A blue-tit built its nest and hatched nine young tits in a pump at Durrant's Farm; the only entrance was the spout, and through the spout ingress and egress were successfully maintained. Another tit built its nest in the letter-box at Mr. George Rooper's farm-gate; a third selected an old boot. The boot, which contained both nest and eggs, was brought to Dr. Brett for inspection. It was found in the hedge opposite Miss Hibbert's on the Hempstead Road. On the 9th of March a robin was found to be sitting on five eggs inside the greenhouse at Watford House; the nest was built on an artificial rockery composed principally of cork. The robins were observed to enter by means of a hole through which the stem of one of the vines found its way into the greenhouse.

Mr. E. S. Fordham informs me that two or three linnets' nests have been found at Elbrook House, Ashwell, in Brussels-sprouts that had run to seed. The same gentleman reports the nest of a tree-creeper as having been built in an old thrush's nest.

Singular occurrence in an Aviary.—Mr. E. R. Raitt has been good enough to send me the following anecdote:—In the garden of the Red Lion Hotel, High Barnet, is a large aviary, containing several different kinds of birds. On the 16th of April, whilst feeding them with bread, I was surprised to see a ring-dove make a furious

attack upon a cock silver-pheasant. A peahen was attempting to drive the pheasant away from the crumbs, when suddenly I heard a screech and a rush from overhead, and was astonished to see a ring-dove darting at the silver-pheasant and continuing to do so after the peahen had retreated. The ring-dove carefully avoided the return attack, and sheltered itself from the pheasant by making use of the rim of a fountain, from which vantage ground it made its darts. I was afterwards informed that the pheasant had killed the ring-dove's mate, together with two young ones, and that ever since that event the ring-dove had never lost a chance of attacking the pheasant, but always in the most wary manner.

General Remarks.

It will be observed that I have little of a sensational character to report on the present occasion. The year 1883 has differed in many respects from its predecessor. During the winter of 1882-83 fieldfares were extremely scarce; they have been abundant during the past season. During 1882 the larger Raptores were reported in unusual numbers from almost every part of the county; on the present occasion I have but very few to record. In 1882 the occurrence of several sea-birds, rarely met with in the midland counties, was a marked feature in the ornithological record of the year. In 1883, notwithstanding the recurrence of storm and tempest, sea-birds have been scarce within the limits of our county; the puffin picked up near Royston, and the whimbrel shot at Buckland, being the most conspicuous among them. Swifts have been extremely abundant. Bramblings and snow-buntings have not once been reported, their absence being readily accounted for by the mildness of the late winter.

Perhaps I may be allowed to state that two "*raræ aves*" have occurred during the autumn just beyond the boundary of Hertfordshire. A black redstart was repeatedly observed in a garden almost close to Luton, and a waxwing was shot not far from Royston, but, most unfortunately for our register, in Cambridgeshire.

Hitherto I have only recorded birds which have been observed since the commencement of the year 1877. I now propose to open a supplementary register, and to record well-authenticated occurrences prior to that date, and I hope that, in this manner, I may be able to add several important species to our present list. In making the attempt I have once more to solicit the active co-operation of all our members, and especially of those who are interested in ornithological pursuits.

X.

REPORT ON INSECTS OBSERVED IN HERTFORDSHIRE DURING THE YEAR 1883.

By F. W. Silvester, F.R.Met. Soc.

Read at Watford, 15th April, 1884.

In presenting a report on that branch of Natural History of which I have now the honour of being your recorder, I must claim indulgence for two reasons. Firstly, I have the disadvantage of succeeding in this office our skilled honorary member Miss E. A. Ormerod, Consulting Entomologist to the Royal Agricultural Society, who, in addition to other valuable papers, gave us our first two reports on this subject; and secondly, I have but scanty materials available as the basis of this report. A very few members only have sent me notes of any sort, and the majority of these are the dates of first appearances of insects recommended for observation.

For this latter information I am indebted to the following:—

At Watford, Dr. Brett and Mr. John Hopkinson; at St. Albans, Mr. A. E. Gibbs; at Harpenden, Mr. J. Willis; at Hertford, Mr. R. T. Andrews; at Sawbridgeworth, Miss Simpson; at Hitchin, Mr. Hill, and other members of the Hitchin Natural History Society; at Royston, Mr. A. Kingston.

The observations are as follows:—

Melolontha vulgaris (cock-chafer), seen at Hitchin, May 14th; at Harpenden, May 25th; at Sawbridgeworth, June 3rd.

Rhizotrogus solstitialis (fern-chafer, or July-chafer), at Hitchin, June 29th.

Lampyris noctiluca (glow-worm), at Watford, June 17th; at Harpenden, June 20th.

Apis mellifica (honey-bee), at St. Albans, January 1st; at Harpenden and at Royston, January 20th; at Watford, January 22nd; at Hertford, February 5th.

Vespa vulgaris (common wasp), at Hertford, April 2nd; at Watford, May 20th.

Pieris Brassicæ (large garden white or cabbage-butterfly), at Harpenden, March 5th; at Watford and Hertford, April 5th; at Watford, April 8th (four seen); at Royston, April 26th; at Hitchin, May 6th.

Pieris Rapæ (small white cabbage-butterfly), at Hitchin, April 1st; at Royston, April 2nd; at Harpenden, April 4th; at Hertford, April 5th; at Watford, April 7th.

Anthocharis cardamines (orange-tip butterfly), at Hitchin, May 5th.

Epeniphile janira (meadow-brown butterfly), at Hertford, May 16th; at Harpenden, May 22nd; at Hitchin, June 24th.

Bibio Marci (St. Mark's fly), at Hitchin, April 18th (few), ditto, 30th (abundant); at Harpenden, July 1st.

From the above notes it will be seen that at six of the seven

localities from which observations were recorded, the large cabbage-butterfly was observed, and that it was first seen as early as March 5th. Mr. John J. Willis, writing from Harpenden, says: "Owing to the unusually large numbers of *Pieris Brassicæ* and *Mamestra Brassicæ* during the present year, the cabbage tribe in the gardens of this neighbourhood are suffering terribly from the depredation of their caterpillars, sprouting broccoli and savoys being specially affected." Dr. Brett sent me a specimen found as early as January 28th of this year by the Rev. Newton Price. This should rightly appear in next year's report, but the early date induced me to think that its insertion here would be interesting, and therefore excusable. It is worthy of notice that, generally speaking, in field-cultivation, cabbage-butterflies are scarce, and this has been especially remarked in the large market-gardens on the rich alluvial tracts near Brentford and Isleworth, and the reason probably is because there is not the same relative amount of shelter in sheds, or amongst walls and palings, or neglected nooks, generally afforded in field-cultivation for the change of the caterpillar to the chrysalis, as there is in gardens. *Pieris Rapæ*, the small white cabbage-butterfly, was observed at five of the localities, and the honey-bee came in for an equal amount of attention. Mr. A. E. Gibbs, of The Hollies, St. Albans, writes that the 1st of January being a mild day, his bees were flying, and he saw them several times on the wing during the previous month (December, 1882). From Royston, Mr. A. Kingston informs me that on January 20th the honey-bee was very busy on the wing in search of a spray of *Jasminum nudiflorum*. Mr. R. T. Andrews, of Hertford, does not tell quite such a happy tale, but one which points a useful lesson as the method in which a mild winter often diminishes the number of hybernating imagos. To quote his own words: "The honey-bee, in consequence of the mildness of the winter, has often been enticed out, but only to get chilled and die, and it was not until the 5th of February that it attempted to do any work."

I do not consider these "first appearances" call for much comment, so will pass on to the few notes on injurious insects with which I have been favoured.

One of the great attacks of the year has been that of the celery- and parsnip-leaf miner-fly, *Tephritis onopordinis*. Both Dr. Brett and Mr. Willis report it as abundant, and in my own garden it did great harm. Although our county suffered much from the celery-miner, as *Tephritis onopordinis* is sometimes called, some gardens were fortunate enough to escape it. This fly is injurious by means of its larva or maggot, which feeds between the two coats of the leaf, and by separating them gives rise to the large discoloured blisters which in their spread destroy the foliage and are the characteristic mark of the attack. The fly may be seen in great numbers during May, and grubs may be found in the leaves until the celery is taken up at Christmas. So all trimmings should be destroyed and not thrown on the rubbish-heap, where the grub will simply avail itself of its opportunities, and, instead of dying, go

down comfortably into any shelter and there turn to a chrysalis to foster the pest for another season. In this, as in all other insect-attacks, it is obvious that if the growth be supported, the maggot cannot do much harm. We should bear in mind that celery in its wild state is a water or ditch plant, and that it suffers much from drought; therefore a plentiful supply of water is desirable. This makes the manure at the roots available, and pushes on the young plant out of harm's way. And it is important, in the removal of the young plant, to avoid, as far as possible, all checks to the tendrils. Sprinkling the leaves, when wet, so that the application adheres for some time, with a good coat of anything the fly dislikes, is sure to assist in preventing the fly from egg-laying. "Little's Soluble Phenyle," very largely diluted in water and syringed over the plants, was tried with great advantage at Dunster Lodge. It is highly valuable in many cases of insect attacks, due care, of course, being taken as to diluting, and not allowing it to collect in pools on leafage. One table-spoonful in one or two gallons of water is often quite sufficient.

The larvæ of *Tipula oleracea*, commonly known as daddy-long-legs grubs, committed great damage on many farms to the young wheat, till the cold weather checked their ravages. The grub gnaws the young plant just below the surface of the ground, and often does great harm to it if it does not destroy it. Gas lime, applied six weeks after it came from the gasworks, was tried with great effect by Miss Ormerod, whose 'Manual' will be found teeming with information as to remedies for, and prevention against, the attacks of this and many other injurious insects.

Mr. Willis writes of the turnip-fly (*Phyllotreta undulata*): "During the month of June, the fly was exceedingly busy amongst the turnip-crops, and large areas in the immediate neighbourhood of Harpenden were almost entirely destroyed; but when a second sowing of seed was made, as soon as the defalcations were discovered, a tolerable plant was eventually secured." As a rule, the attack was not general throughout the county, and in the neighbourhood of St. Albans we did not suffer much from it. The same gentleman sends the following interesting note:—"A species of small fly also greatly infested the young plants of clover about the same period of the year, and in many cases so far injured the crop as to render it necessary to plough up the land."

We had a troublesome pest in the turnip and cabbage-root maggot, supposed to be the larvæ of *Anthomyia* of the species *Brassicæ* and *radicum*, but which recent observations have shown to be often *Anthomyia floralis*. I have noticed on my farm at Hedges, near St. Albans, that the turnips invariably suffer more from this maggot after the recent application of farm-yard manure, than when the manure has been applied in the autumn and the crop is only supplied with superphosphate in the spring. This appears a suitable opportunity to mention that the Royal Agricultural Society of England has issued a circular inviting notes on "eggs, grubs, and maggots of injurious insects in manure and compost heaps." As

the recorder for Hertfordshire, I shall be happy to furnish any members with a "Schedule of points for observation and experiment," if any should be desirous of taking up this useful field of labour, in which our honorary member, Miss E. A. Ormerod, is interested, as it is her intention, by desire of the Royal Agricultural Society, to devote a special report to it, with the co-operation of Mr. Whitehead, the chairman of the Seed and Plant Diseases Committee of that Society; it being "important to collect evidence as to whether insects that feed upon manure in certain stages of their lives are attracted to growing crops by the smell of manure, and whether any measures have been adopted to counteract this."

I am indebted to Mr. A. E. Gibbs for the following interesting note:—"The wax-moth (*Galleria cereana*) was very troublesome in my apiary this past season. When I removed a number of empty hives indoors for the winter, I found that in a few days the rooms in which they were put were much infested with these troublesome insects. It should be mentioned that the hives had been standing empty in the garden for some weeks, and that my other hives were also more infested than usual with the grubs of the wax-moth." I thought I could not do better than write to the indefatigable honorary secretary of the Hertfordshire Beekeepers' Association for information on this head. The Rev. John Lingen Seager replied as follows:—"The only cure for moth is carefully to search both hive and quilt and destroy the grubs. They are often to be found in the saw-cut at the top of the frames into which the foundation is put; also especially in old carpet-quilts. I always take all my quilts off twice a year and bake them in the oven; if they are dirty, I scald them first. The moth generally gets in under the roof, which in ninety-nine hives out of a hundred does not fit properly. Some people always keep a lump of camphor laid on the quilt. I do not think this a bad plan. Old bits of comb left lying about near the hives are sure to encourage the moth."

In bringing this report to a conclusion, I have to thank most cordially those members of our Society and others who have furnished me with notes of their observations. I only wish it had been in my power to compile the matter entrusted to my care in a manner more worthy of your acceptance. I am most grateful to Miss E. A. Ormerod for kindly help and valuable counsel. We all regret that her increasing beneficial labours to the country at large have compelled her to resign the post of recorder for injurious insects, but she assures me that she will ever be ready to help our Society in any way that lies in her power. Members will find her newly published 'Guide to Methods of Insect Life' full of information. I hope a perusal of it will induce greater numbers to send in their observations to me during the present year.

XI.

NOTES ON THE PROTOZOA OF HERTFORDSHIRE: SECTION DISCOSTOMATA.

By F. W. Phillips, F.L.S.

Read at Hertford, 28th February, 1884.

PLATE VI.

During the last session I had the honour of reading before this Society the first of a series of papers having for their aim the record of those species of the Protozoa which have been found in the county. In that paper I gave an account of the lowest and simplest forms of life known to science—mere specks of animated jelly—having neither mouth nor any other organ whereby food can be taken into the body, and subsisting by the mere absorption of small or invisible particles contained in the liquid medium through which they move; the majority of these creatures often being of so small a size as to defy the highest powers of the microscope. Upon this first section has been bestowed the name Pantostomata, a word meaning "all mouth."

I now purpose giving an account of the second section, called, in reference to the circumscribed area in which food can be incepted, Discostomata. This section, as I shall presently show, is closely allied to the previous one; the line of division which has been drawn is simply one of convenience, having no real existence; indeed, this is the case with all other such lines of demarcation. One cannot go very far into the study of plant- or animal-life without finding that there is no such thing as a hard and sharp line or division in the whole realm of Nature, but one gradually ascending scale, from the lowest forms, up to man himself. The present section, which I am about to describe, is one of those which have a peculiar fascination for the biologist, because, although the members thereof are of so lowly and humble a nature, yet they are rich in those foreshadowings, as it were, of organs which belong to more highly-organised creatures.

A further interest centres in this section, because a knowledge of it is the harvest of the most recent microscopical research; the long immunity from investigation which this group has enjoyed being doubtless due to their excessive minuteness. Compared with them, the larger number of the ciliate infusoria with which we have been so long familiar are very giants. The "tiny vorticella" is often spoken of as an emblem of minuteness, and yet its spirally-unfolding stem is the world upon which many of these creatures live. I will not inflict upon you a number of figures, but content myself with the statement that the largest individual does not exceed the one-thousandth part of an inch in length, while the average dimension may be computed at the inconceivable size of the three-thousandth part of an inch.

Before entering into details of the structure of the Discostomata, I will say a few words about their history. To the late Prof. H. James Clark belongs the honour of being the first to give a definite record of these creatures. In June, 1866, he communicated to the Boston Natural History Society a detailed account of four species he had discovered. The Discostomata had been previously recognised by Ehrenberg and Stein, but they had supposed them to be minute species of the genus *Epistylis*. Their true organisation was not known until Mr. W. Saville Kent, in a paper read before the Royal Microscopical Society in 1878, fully described the precise import of the remarkable collar-like membrane which characterises the group, although he had previously, on the 21st of June, 1877, read a paper relating to them before the Linnean Society. Since then he has devoted great attention to them, and the result has been that, although more than fifty species have been recorded, more than two-thirds of this number have been registered by this most indefatigable worker.

The animalcules included in the section Flagellata-Discostomata may be described as exceedingly minute, very variable and changeable in form, but, in normal adult stages, of an ovate or pear-shaped form, having at their anterior extremity a single, long, lash-like, appendage, called a flagellum, which is surrounded and partially enclosed by an exceedingly delicate and transparent membrane, which rises from the base of the flagellum in the form of a funnel or wine-glass; this membrane, like the flagellum, is merely an extension of the substance of the body, and can be either contracted into a cylindrical form, withdrawn into the body, or extended at will. The area in which food can be taken into the body is limited to the place or part enclosed by this collar-like membrane, and from this part are also discharged all fæcal or waste products. They possess a distinct nucleus, and have one or more contractile vesicles. They inhabit salt and fresh water.

Without doubt the most interesting feature is the remarkable distinguishing membrane, from the possession of which the animalcules are familiarly called "collared monads." Such is the extreme delicacy of this membrane that with all ordinary high magnifying powers it can only be seen in profile like two fine, curved hairs, and as such it has been delineated by Stein, De Fromental, Butschli, Fresenius, Carter, and other modern writers; and it can only be defined by the most careful and delicate adjustment of the light, and the employment of the power known as a $\frac{1}{50}$th objective, giving the extraordinary linear magnification of 5000 diameters. Yet it must be remembered that notwithstanding this almost incomprehensible tenuity, it is merely an extension of the substance of the body, and is undergoing a constant change up the outside and down the inside, where it enters, and is merged in the protoplasm of the body (there are two surfaces, inner and outer, which, as it were roll or glide over each other). This action (which the mind when remembering the excessive thinness can hardly grasp) can be seen with an ordinary high magnifying power, and it is by this action

that the creatures obtain their food. Mr. Saville Kent, in his 'Manual of the Infusoria,' describes the process so beautifully that I think I cannot do better than quote the passage. "Whirling round with inconceivable rapidity, the flagellum creates a strong centrifugal current in the water, setting in behind towards the direction of its own apex, and bringing with it all such tiny particles as do not possess sufficient power or weight to stem its tide; but for the outstretched collar, these would simply hurry with the stream past the monad's body. Not for them, however, so easy a passing of the rapids. In the midst of their swift career they strike against the almost impalpable film of sarcode of which the organ is composed, and to this they adhere as tenaciously as a snared bird to a lime-daubed twig, or an incautious fly to a spider's web. Then slowly, almost imperceptibly, the captive atoms are carried up the outside and down the inside, until, reaching the base of its inner surface, they are engulfed within the sarcode substance of the monad's body." The particles thus taken into the body gradually accumulate into spherical masses in the same manner as in the Vorticellidæ, and the undigestible particles are eventually ejected from the same area wherein they were originally incepted.

The other features, e.g. the nucleus, and the contractile vesicles, were fully treated of in my previous paper on the section Pantostomata; there is therefore no necessity for further remark on these points. Although great similarity of shape exists in the bodies of the animalcules, yet in their loricæ or protective envelopes we find great diversity; all are of exquisite form and contour, often exactly resembling the amphoræ, lachrymariæ, or the tear-bottles and other vases of ancient Greece.

After the above brief description of the anatomy of the collared monads, little remains but to mention and describe those species which have come under my observation.

We must of course take them in the order of classification, which divides the section into three families. The first, called Codonosigidæ, includes all those species which are naked, *i.e.* which secrete no protective envelope; the second, Salpingœcidæ, embraces those forms which secrete a lorica; and in the third, Phalansteridæ, we find the animalcules associated and secreting a gelatinous mucus which forms extensive colonies.

The first family, Codonosigidæ, is subdivided into four genera: *Monosiga*, in which the animalcules are solitary and isolated; *Codosiga*, which includes all which are united socially in a cluster on a common pedicel or stalk; *Astrosiga*, so called from the stellate form of the groups, which swim freely through the water; and *Desmarella*, so called from the chain-like form of the clusters.

I have found several species of the first genus, *Monosiga*. Firstly, *M. consociata*, which, as the name implies, is of gregarious habits. It was found upon a confervoid filament, attached, not by a footstalk or pedicel, but by merely resting upon the weed, a frequent mode of attachment technically termed *sessile*; the monad is

of a pear-shaped form, and has a well-developed collar and flagellum, which (as in all other members of the family) can be entirely withdrawn into the body. Mr. Saville Kent gives in his 'Manual' two figures, showing their withdrawal, the monad having changed into an amœboid form. The members of this genus multiply by fission, or self-division, and the newly-formed animalcule swims off as a simple monad, but, after finding a resting-place, developes in due time the characteristic collar. Of this genus I have also found *M. Steinii*, which is of a more even contour, equal at both extremities, and was found sparingly distributed, on the stem of *Vorticella campanula:* it is named specifically after its discoverer Friedrich Stein. Also, *M. fusiformis*, which is spindle-shaped, and sharply pointed at both extremities. Both species, like the first, are sessile. *M. globosa* is another species of this genus, but distinguished from the foregoing by its globular form, and more particularly by the possession of a long straight pedicel of great delicacy. This species was taken from water collected in the hollows formed by the roots of beech-trees in Ware Park. If searched for with a high power, it would probably be overlooked, as the length of its pedicel places the body at some distance from the object to which it is attached.

We now come to the second genus, *Codosiga*, in which the various species are distinguished by being united in social clusters by a fixed, rigid, branching pedicel (technically termed a zoodendrium). The commonest form is *C. botrytis*. Being imperfectly observed by Ehrenberg, it was described by him as *Epistylis botrytis*. It is exceedingly abundant in many ponds. I may instance the pond in Mangrove Lane, near Hertford, from which I rarely take a dip without finding this beautiful form attached to *Myriophyllum*, and to the ivy-leaved duckweed (*Lemna trisulca*), often in such abundance as to present the appearance of a perfect forest of vegetation. The animalcules of this species are of a symmetrically-ovate form, attached in clusters of from two to twenty zooids to the extremity of the various branches of the zoodendrium. A peculiar feature in the species is the habit of putting forth certain rod-like bodies before undergoing encystment: on a casual inspection these appear to be merely particles of adherent matter. Their distinct connexion with the body was traced by Mr. Saville Kent, who at one time considered that the possession marked a distinct species, upon which, from its bristling appearance, he conferred the title of *Codosiga echinoides;* but a subsequent and prolonged examination showed him that these rod-like bodies were pseudopodic projections. Usually, but not always, the collar and the flagellum are withdrawn into the body previous to this amœboid phase. Then follows the encystment, the cuticle becomes hardened, and the enclosed protoplasm breaks up into a number of spores. Stein believes that a genetic conjugation with some other free-swimming animalcule precedes this encysting process. Mr. Saville Kent records a peculiar phenomenon, which I have also observed in connection with the group, viz. that when subjected

to undue pressure, they throw out a film of sarcode, giving the appearance of a delicate sheath or lorica, and ultimately withdraw the collar and flagellum; but when the pressure is removed, the normal condition is gradually resumed.

The next genus is called *Astrosiga*, and is limited to a single species. The animalcules, as the name implies, are united in stellate clusters of about five monads, swimming freely in the manner of *Uvella*. It does not appear to have ever been found in England.

There is one other free-swimming form, which constitutes the next genus, *Desmarella*, in which the animalcules are united in chain-like rows, moving very rapidly through the water by the action of their combined flagella, rendering observation a difficult matter. With the exception of one species described by Stein, the members appear to be confined to salt-water habitats.

We now come to the second family, Salpingœcidæ, in which the members secrete a lorica or protective case, and it is here that we find the greatest diversity and wealth of form. Taking first those species in which the pedicel is rudimentary, we have *Salpingœca amphoridium*, in which the lorica (which is the basis of classification) is shaped like a Florence flask, or water-carafe. It is by far the most common species of the genus. When found upon confervoid filaments, the animalcules are often as closely packed as are the cells in a beehive, and, were it not for their extreme transparency, would often obscure the view of their resting-place. There is a great tendency in these animalcules to alter their shape; the tiny speck of protoplasm often grows too large for its little crystal cell, and then bubbles out, pushing aside the collar and flagellum, which are often withdrawn; and the finger-like processes, which are sometimes assumed by the sarcode, remind one of a *Difflugia*. Ultimately, this redundant sarcode is separated from the parent body, floats or crawls off in the manner of an *Amœba* (for which it might easily be mistaken if first encountered in this stage), and, after a short time, settles down and developes into a collared monad resembling the parent, which also, after fission, draws back into the lorica, and gradually assumes its pristine contour.

Another very beautiful form which I have met with very frequently at Hertford Heath is *S. fusiformis*. Its exquisite vase-like contour must at once arrest attention. A wide departure in form is shown by *S. ampulla*, a species inhabiting salt-water, which has not come under my observation, but which I feel that I can hardly pass without notice. Here we find that part of the lorica which surrounds the collar inflated in a beautiful balloon-like manner, and marked by longitudinal sulcate ridges.

Even more remarkable, perhaps, is another marine form, *Salpingœca cornuta*, in which the development of the lorica was until recently without parallel amongst recorded forms, being from seven to ten times as long as broad, and greatly resembling the curving horns of certain antelopes. I have recently discovered a new species in which an analogous growth is present. I propose to provisionally bestow upon it the specific name *tuba*, in reference to the

shape of the lorica. A group of individuals was found in the fork of a piece of *Myriophyllum spicatum*. The species may be thus described:—

Salpingœca tuba, sp. nov.—Loricæ tube-like or cylindrical, of even diameter throughout the entire length, about twenty times as long as broad, and often bent or curved in the middle, or flexuous; enclosed animalcule sessile, situated near the anterior extremity of the lorica, and having a collar cylindrical in form.

Amongst those members of the same genus in which the footstalk is conspicuously developed may be noted the elegant *Salpingœca gracilis*, of an elongated-wineglass form. This species may generally be obtained in great plenty in the Manifold Ditch, near Hertford. There are two other genera in this family, *Lagenœca* and *Polyœca*, but I have not yet found representatives.

By a reference to the third and last family I must bring my remarks on the order to a close. The family Phalansteridæ includes all those animalcules possessing the essential characteristics previously referred to, but inhabiting a mucilaginous zoocytum or protective envelope; but only one example of the family appears to have been found in England.

I feel that it would be impossible to leave the subject without mentioning that recent research, extending over the last four years, and the unremitting labours of Prof. H. J. Clark, Mr. R. Carter, Oscar Schmidt, the late Prof. Balfour, Mr. Saville Kent, and other workers, has elicited almost beyond doubt the important fact that the large group of organisms known as the Spongidæ are all simply vast aggregations of collared monads. The limits of this paper preclude more than this passing notice, but I would in conclusion commend to the inquiring reader the chapters on the same contained in the 'Manual of the Infusoria' by Mr. Saville Kent. I am chiefly indebted to this work for my information on the subject.

EXPLANATION OF PLATE VI.

Fig. 1. *Monosiga consociata*. 1a. A zooid with collar and flagellum withdrawn, and about to enter upon an encysted state. 1b. Zooids assuming a vacuolar amœboid phase.
,, 2. *M. Steinii* attached to stem of *Vorticella*.
,, 3. *M. fusiformis*—a social group.
,, 4. *M. globosa*.
,, 5. *Codosiga botrytis*. 5a. A zooid emitting pseudopodic processes.
,, 6. *Astrosiga disjuncta*.
,, 7. *Desmarella moniliformis*.
,, 8. *Salpingœca amphoridium*. 8a. The collar protruded in the form of filamentous pseudopodia.
,, 9. *S. fusiformis*. 9a. A zooid assuming an amœboid state. 9b. An encysted zooid. 9c. The same broken up into numerous spore-like bodies. 9d. The same with the bodies further developed and discharging as mono-flagellate germs.
,, 10. *S. sulcata*.
,, 11. *S. cornuta*.
,, 12. *S. tuba*, sp. nov.

XII.

LIST OF FLOWERING PLANTS OBSERVED IN HERTFORDSHIRE DURING THE YEAR 1883.

By Ada Selby.

Read at Watford, 15th April, 1884.

Lists of flowering plants observed in 1883, the occurrence of which in the localities specified it is desirable to record, have been communicated by Mr. A. E. Gibbs of St. Albans, Mr. A. F. Griffith of Sandridge, Mr. John Hopkinson of Watford, and the Rev. C. J. Langley of Berkhamsted. The surnames of these observers are appended to their records, and the sequence followed is, as before, in accordance with the seventh edition of the 'London Catalogue of British Plants.'

Thalictrum flavum.—Marford Bridge; *Griffith.*

Anemone Pulsatilla.—Hill-side above Tring Station; *Langley.*

Helleborus viridis.—Copse at Callow Land, Watford; woods near Long Green, Berkhamsted; *Hopkinson.* Hill End Wood, Sandridge; Sallow Wood, Coleman Green; *Griffith.*

Berberis vulgaris.—Brocket Park; *Griffith.*

Corydalis lutea.—On old wall, Berkhamsted; *Langley.*

Hypericum Androsæmum.—Symond's Hyde Sandridge; *Griffith.*

Malva moschata.—Sandridge, common; *Griffith.*

Geranium pratense.—Near Redbourne; *Hopkinson.*

G. nodosum.—Wood-walks, Cassiobury Park, apparently established as an escape; *Hopkinson.*

Erodium cicutarium.—Sandridge; *Griffith.*

Impatiens fulva.—Swiss Cottage woods, Cassiobury Park; *Hopkinson.*

I. parviflora.—Swiss Cottage woods, and wood-walks, Cassiobury Park; *Hopkinson.*

Rhamnus catharticus.—Sandridge; *Griffith.*

Genista tinctoria.—Symond's Hyde, Sandridge; *Griffith.*

Melilotus alba.—Near Berkhamsted Station; *Langley.*

Trifolium subterraneum.—No Man's Land, Sandridge; *Griffith.*

T. ochroleucum.—Dead Woman's Land, Sandridge; *Griffith.*

Astragalus hypoglottis.—Near Baldock, on the road to Stevenage; *Griffith.*

Lathyrus Nissolia.—Well Wood, Sandridge; *Griffith.*

Spiræa salicifolia.—Site of old nursery, St. Albans; *Gibbs.*

Potentilla argentea.—Near Rickmansworth; *Gibbs.*

Epilobium angustifolium.—Symond's Hyde, Sandridge; *Griffith.*

E. hirsutum.—Lempsford Mills, Harpenden (with white variety); *Griffith.*

Saxifraga granulata.—Meadows near Hamper Mills, Watford; Meadows at Redbourne, St. Albans.—*Hopkinson.* Near Brocket Hall; *Griffith.*

Parnassia palustris.—River Lea, near Sandridge; *Griffith.*

Helosciadium inundatum.—By the brook, Elstree; *Gibbs.*
Viscum album.—Hatfield Park, on hawthorns, etc.; *Griffith.*
Adoxa Moschatellina.—Hedges Farm, St. Albans, *Hopkinson.* Near Marshall's Wick, Sandridge; *Griffith.*
Carduus palustris.—Sandridge (with white variety); *Griffith.*
C. pratensis.—Cold Harbour, Harpenden; *Gibbs.*
C. acaulis.—No Man's Land, Sandridge; *Griffith.*
Centaurea Cyanus.—Sandridge; *Griffith.*
Senecio silvaticus.—Symond's Hyde, Sandridge; *Griffith.*
Erigeron acris.—Railway cuttings, Sandridge; *Griffith.*
Petasites vulgaris.—River Lea, near Sandridge; *Griffith.*
Cinchona Intybus.—Near Berkhamsted Station; *Langley.*
Tragopogon pratensis.—Sandridge, not common; *Griffith.*
Vinca minor.—Ayers End, Wellwood, etc., Sandridge; *Griffith.*
Erythræa Centaureum.—Symond's Hyde, Sandridge (with white variety); *Griffith.*
Menyanthes trifoliata.—River Lea, near Sandridge; *Griffith.*
Cuscuta Trifolii.—Sandridge, very common; *Griffith.*
Atropa Belladonna.—Brocket Park; *Griffith.*
Verbascum nigrum.—Stanborough; *Griffith.*
Scrophularia vernalis.—Berkhamsted Common; *Langley.*
Linaria repens.—Railway cuttings, Wheathampstead; *Griffith.*
Pedicularis palustris.—Symond's Hyde, Sandridge; *Griffith.*
Lathræa squamaria.—Near Water End, Sandridge; *Griffith.*
Orobanche minor.—Ayers End, Harpenden; *Griffith.*
Mentha Pulegium.—Near Aldenham; *Gibbs.*
Nepeta Cataria.—Copse on Tring road, Berkhamsted; *Langley.*
Marrubium vulgare.—Berkhamsted; *Langley.*
Galeopsis Ladanum.—Sandridge (with white variety); *Griffith.*
Myosotis collina.—Berkhamsted Castle walls; *Langley.*
Daphne Laureola.—Near Wheathampstead; *Griffith.*
Euphorbia stricta.—Hemel Hempstead; *Gibbs.*
Butomus umbellatus.—Near Hill End, Sandridge; *Gibbs.*
Habenaria chlorantha.—Symond's Hyde woods, Sandridge; *Griffith.*
Ophrys apifera.—Symond's Hyde, Sandridge; *Griffith.*
Cephalanthera grandiflora.—Woods near Long Green, Berkhamsted; *Hopkinson.*
Narcissus Pseudo-narcissus.—Sandridge; *Griffith.*
Allium ursinum.—Loudwater, Rickmansworth; *Hopkinson.*
Scirpus lacustris.—The Ponds, Gorhambury, St. Albans; *Gibbs.*
Carex disticha.—Wet meadows, Redbourne Bury, St. Albans; *Gibbs.*
C. paniculata.—Harpenden; *Gibbs.*
C. pallescens.—Bricket Wood; *Gibbs.*
C. pendula.—Near Shenley; *Gibbs.*
C. lævigata.—Brook, Hedges Farm, St. Albans; *Gibbs.*
C. vesicaria.—Cunningham Hill, St. Albans; *Gibbs.*

XIII.

METEOROLOGICAL OBSERVATIONS TAKEN AT THROCKING, HERTS, DURING THE YEAR 1883.

By the Rev. C. W. Harvey, M.A., F.R.Met.Soc.

Read at Hertford, 25th April, 1884.

Position of Station, Lat. 51° 57′ N., Long. 0° 3′ W., Rib District; *Height of Station above sea-level*, 484 feet; *Times of Observing*, 9 a.m. and 9 p.m.

There is little in the meteorology of 1883 which strikes one as in any degree abnormal. That which attracted the greatest amount of interest was, no doubt, the very remarkable sunsets of November and December, for which it seems difficult to find a satisfactory solution.

In the table in which I usually compare the year with an average year, I have determined for the first time to dispense with the pressure and temperature values of other places, *i.e.* London and Yarmouth, and to confine myself entirely to that which relates to my own station. Having only the observations of four years complete, the set of means with which I have ventured to compare the year 1883 cannot be said to represent the normal state of either pressure, temperature, or rainfall at this particular station. A four-year period is, I know, much too short to give very reliable results; still, as years go on, this table will, I hope, become more and more reliable.

Months.	Pressure.		Temperature.		Rainfall.	
	Mean	Diff.	Mean	Diff.	Mean	Diff.
	1880–83	1883.	1880–83	1883.	1880–83	1883.
	ins.	in.	°	°	ins.	in.
January	30·11	—·18	34·7	+3·7	1·22	+ ·53
February	29·94	—·01	39·4	+1·7	2·68	+ ·87
March	29·80	+·15	41·0	—6·7	1·04	— ·40
April	29·92	+·13	45·4	+0·5	1·87	— ·08
May	30·05	—·13	51·1	—0·9	·99	+ ·17
June	29·92	+·05	56·8	+0·4	2·11	+ ·09
July	29·91	—·07	60·4	—2·3	3·16	+ ·28
August	29·86	+·13	59·0	+1·2	2·36	— ·72
September	29·90	—·06	57·7	—2·4	2·81	+1·23
October	29·91	+·04	47·9	+2·7	3·68	—1·66
November	29·80	=	42·4	—1·4	2·62	+ ·09
December	29·91	+·21	38·3	—0·7	2·58	— ·57
Year	29·94	=	47·8	—0·3	27·12	—1·17

Results of Meteorological Observations taken at Throcking Rectory, Herts, in 1883.

Months.	Pressure of the Atmosphere.	Temperature of the Air.										Humidity of the air.		
		9 a.m.	Means of		Adopted Mean.	Mean Daily Range.	Absolute Min. and Max.				Absolute Range.	Dryness.	Tension of Vapour.	Relative Humidity.
			Min.	Max.			Min.	Date.	Max.	Date.				
	ins.	°	°	°	°	°	°		°		°	°	in.	%
January	29·93	38·0	33·5	43·0	38·4	9·5	26·1	24th	52·4	1st	26·3	2·6	·207	90
February	29·93	40·0	35·0	47·0	41·1	12·0	28·9	24th	54·5	24th	25·6	1·9	·230	93
March	29·95	33·2	28·0	41·1	34·3	13·1	17·6	24th	57·5	4th	39·8	2·2	·173	91
April	30·05	46·5	37·2	55·4	45·9	18·2	28·9	24th	68·5	5th	39·2	6·0	·253	80
May	29·92	53·1	41·5	60·1	50·2	18·6	28·7	4th	77·5	24th	48·8	5·7	·327	81
June	29·97	57·7	48·7	67·0	57·2	18·3	41·9	12th	80·0	30th	38·1	5·0	·399	83
July	29·84	58·0	50·3	67·2	58·1	16·9	42·9	16th	77·3	2nd	34·4	4·2	·415	85
August	29·99	61·2	52·2	69·3	60·2	17·1	45·4	12 & 17	78·9	13th	33·5	5·8	·440	81
September	29·84	55·4	48·9	62·4	55·3	13·5	42·4	6th	72·7	18th	30·3	1·9	·441	93
October	29·95	48·5	43·5	58·1	50·6	14·6	35·1	2nd	63·9	27th	28·8	1·3	·325	96
November	29·80	40·6	34·9	47·1	41·0	12·2	28·9	12th	54·4	28th	25·5	0·5	·240	96
December	30·12	37·2	33·2	41·6	37·6	8·4	29·4	6th	51·8	14th	22·4	1·4	·218	95
Year	29·94	47·4	40·5	54·9	47·5	14·4	17·6	Mar. 24	80·0	June 30	62·4	3·2	·306	89

RESULTS OF METEOROLOGICAL OBSERVATIONS TAKEN AT THROCKING RECTORY, HERTS, IN 1883—(*continued*).

MONTHS.	RAINFALL.					CLOUD.			WIND.									
	Total Fall.	Max. fall in 24 hours.		No. of days of		Mean Amount 0–10.	No. of days of		Mean Force 0–12.	Number of days of								
	Ins.	Ins.	Date.	Rain or Snow.	Snow only.		Clear Sky.	Over-cast.		N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Calm.
January	1·75	·30	29th	22	2	6·8	9	18	2·6	1	0	5	7	5	8	2	3	0
February	3·55	·64	10th	19	0	7·3	6	15	2·4	1	0	1	2	7	3	7	2	5
March	·64	·19	19 & 30	10	5	5·9	6	9	2·5	6	4	5	1	3	2	0	8	2
April	1·79	·63	28th	8	0	6·2	4	11	2·2	5	6	2	3	3	1	4	4	1
May	1·16	·35	26th	10	0	3·3	2	10	2·2	9	3	2	0	3	7	2	4	1
June	2·20	·55	15th	9	0	6·6	3	9	2·2	3	7	1	4	5	2	1	5	2
July	3·44	·58	23rd	15	0	4·0	0	10	2·6	1	1	0	3	4	8	9	5	0
August	1·64	·41	3rd	12	0	6·0	5	10	2·1	3	0	1	2	2	5	9	6	3
September	4·04	1·20	29th	15	0	7·1	3	14	2·5	4	3	1	2	6	9	2	2	1
October	2·02	·45	15th	13	0	3·0	0	14	2·8	4	1	1	2	3	12	3	5	0
November	2·71	·43	30th	22	0	6·3	4	12	2·3	3	0	0	2	3	14	2	6	0
December	1·01	·26	10th	14	4	8·0	0	17	2·7	4	2	0	2	0	4	8	4	7
Year	25·95	1·20	Sept. 29	169	11	5·9	42	149	2·4	45	27	19	30	44	75	49	54	22

Pressure.—The mean for the year was exactly the mean for the four-year period. The range of mean pressure has been from 29·96 ins. in 1880 to 29·91 in 1882; the absolute range of pressure being from 30·94 ins. on 18th Jan. 1882, to 28·83 on 18th Nov. 1880, or a total range of 2·11 ins. In the present year the mercury attained its highest point, 30·70 ins., on March 4th, and its lowest, 28·86, on Sept. 2nd, giving a range of 1·84 in. The other dates of high pressure, when it exceeded 30·50 ins., were April 6th and Dec. 25th; and of low pressure, when it was below 29·00 ins., Feb. 2nd and Nov. 6th.

Temperature.—The mean for the year was as nearly as possible the mean for the four-year period. The range of mean temperature has been from 47°·8 in 1883 to 46°·2 in 1881. The absolute range for the whole period is the absolute range for 1881, *i.e.* 89°·6 on July 15th to 10°·7 on Jan. 22nd, or a range of 78°·9. The range for the year was 62°·4. The excess in temperature was most noticeable in January and October, whilst the deficiency was most noticeable in March and July. The middle of winter and of autumn thus were warm, whilst the early spring and the middle of summer were in the one case very cold, and in the other somewhat cold. The first three days of January were exceedingly warm.

1st	Max.	52°·4	Min.	43°·9	Mean	48°·3
2nd	,,	47 ·0	,,	43 ·7	,,	45 ·4
3rd	,,	43 ·2	,,	41 ·5	,,	42 ·3

On the other hand, some of the minima of March were remarkably low for the season, and were the minima of mid-winter rather than early spring.

	In stand	On grass		In stand	On grass
8th	21°·4	23°·6 (*sic**)	13th	25°·2	20°·7
9th	20 ·6	17 ·5	16th	20 ·2	15 ·7
10th	19 ·5	16 ·6	23rd	24 ·4	21 ·6
11th	23 ·4	20 ·1	24th	17 ·6	12 ·8
12th	25 ·7	22 ·6	25th	24 ·4	19 ·7

It may be remarked that while the mean temp. of March 25th, or Lady Day, was as low as 34°·2, the mean temp. of Christmas Day was as high as 40°·7, a difference of 6°·5. As a matter of curiosity I give the readings for these two days.

March 25th	9 a.m	30°·8	max.	44°·6	min.	24°·4	min. on grass	19°·7
Dec. 25th	,,	40 ·3	,,	41 ·6	,,	39 ·9	,,	36 ·8

The four highest maxima and lowest minima during the year were:—

	Highest Maxima.			Lowest Minima.	
(*a*)	June 30th	80°·0	(*a*)	March 24th	17°·6
(*b*)	Aug. 13th	78 ·9	(*b*)	,, 10th	19 ·5
(*c*)	May 24th	77 ·5	(*c*)	,, 9th	20 ·6
(*d*)	July 2nd	77 ·3	(*d*)	,, 8th	21 ·4

Late cold was thus followed by early heat, and the max. of May exceeded that of July. It is not often, I fancy, that in two months, *i.e.* March 24th to May 24th, it is possible to show a range of 60°.

* Snow on the ground at the time.

The warmest and coldest period of 14 days was June 25th to July 8th, and March 6th to 19th, respectively, of which periods I give the mean.

Warmest Period.				Coldest Period.			
June 25th..	61°·0	July 2nd ..	64°·2	Mar. 6th...	34°·2	Mar. 13th ..	33°·7
,, 26th ..	56 ·2	,, 3rd...	67 ·1	,, 7th...	30 ·6	,, 14th...	34 ·5
,, 27th...	64 ·9	,, 4th...	59 ·1	,, 8th...	26 ·5	,, 15th ..	30 ·8
,, 28th...	64 ·3	,, 5th...	58 ·5	,, 9th...	26 ·4	,, 16th...	29 ·7
,, 29th...	65 ·9	,, 6th...	53 ·8	,, 10th...	25 ·5	,, 17th...	37 ·2
,, 30th...	69 ·1	,, 7th...	62 ·0	,, 11th...	29 ·7	,, 18th...	34 ·9
July 1st...	62 ·3	,, 8th...	64 ·7	,, 12th...	31 ·2	,, 19th...	35 ·7
Mean.....	62°·3			Mean.....	31°·5		

Rainfall.—For the first time in the four years, indeed the first time in nine years, *i.e.* since 1874, the rainfall was below the mean for 1870–79; February showing the greatest excess, December the greatest deficiency above and below that mean. September, however, had the heaviest fall; July being also a wet month. *Dry periods.*—In April there was no rain at all until the 18th; nor, if we except a **T S** on May 26th, was there any rain between May 14th and June 15th. *Wet periods.*—Feb. 7—10, when 1·56 fell; April 27—29, when 1·36 fell; July 20—23, when 1·50 fell; and the last four days of September, when 2·25 fell.

The seasons of 1882–83 are given in the usual table:—

Seasons 1882–83.	Mean Pressure.	Mean Temperature.	Mean Daily Range.	Tension of Vapour.	Relative Humidity	Rainfall.
	ins.	°	°	in.	%	ins.
Winter...	29·84	39·0	10·4	·216	92	7·96
Spring	29·97	44·8	19·3	·251	84	3·59
Summer	29·93	58·5	17·4	·418	83	7·28
Autumn	29·93	49·0	15·4	·335	95	8·77

Comparing this table of seasons with that of preceding years, we find that the winter of 1882–83 was the warmest and the wettest, with the greatest range of temperature; the spring was the coldest with the greatest range of temperature; the summer differed materially from its three predecessors; whilst the autumn again showed the highest temperature, and the greatest range. We may therefore, from this table, characterize the seasons thus:—Winter, mild and wet; spring, cold and somewhat dry; summer, rather wet and dull; autumn, warm and humid.

It only remains now to give a few notes on the months, using the usual abbreviations as given in Beaufort's scale. I may add that the accumulated temperature, which is a new feature in my report, is calculated approximately from the mean, max., and min., for each month, and indicates the combined amount and duration of the excess or defect of temperature above or below 42°, the

temperature above which is mainly effectual in starting and maintaining growth, and completing the ripening of the crops. The accumulated temperature-values are from Jan. 1st throughout.

JANUARY.—A mild unsettled month, with intervals of bright weather and a stormy close; **F** on 11th and 19th. *Pressure*, 1·8in. below four-year mean; highest, 30·64 ins., on 23rd; lowest, 29·08, on 26th. The chief depressions occurred on 13th, 16th, and 29th. *Temperature*, 3°·7 in excess of four-year mean; warmest day, 48°·3, on 1st; coldest, 31°·3, on 24th; highest in sun, 90°·0, on 28th; lowest on grass, 22°·1, on 31st; accumulated temp. above and below 42°, respectively 12 and 139 day-degrees. *Rainfall*, ·53 in. above four-year mean; the wettest January, both as regards amount of fall, and number of wet days, yet observed; chief fall besides max., 26 in. on 24th, the product of snow. *Prevailing winds*, S.E. and S.W.; gales on 2nd, and 26th to 29th.

FEBRUARY.—A mild wet month; after the third week, however, the weather became more settled, and temperature increased; **F** occurred on 1st, and to some extent on 5th, 7th, 24th, and 28th. *Pressure*, ·01 in. below four-year mean; highest, 30·64 ins., on 26th; lowest, 28·94, on 2nd. *Temperature*, 1°·7 above four-year mean; warmest day, 47°·8, on 22nd; coldest, 35°·2, on 19th; highest in sun, 100°·4, on 27th; lowest on grass, 26°·1, on 1st; accumulated temp. above and below 42°, respectively 68 and 253 day-degrees. *Rainfall*, ·87 in. above four-year mean; the wettest February yet observed; chief falls besides max., ·62 in. on 2nd, ·26 on 7th, ·44 on 8th; the greater part of the fall occurred early in the month. *Prevailing winds*, S. and W., with gale on 2nd and 10th.

MARCH.—A dry and very cold month, but with a fair proportion of sunshine; **F** on 14th and 19th. *Pressure*, ·15 in. in excess of four-year mean; highest, 30·71 ins., on 4th; lowest, 29·25, on 26th; remained high between 2nd and 5th. *Temperature*, 6°·7 below four-year mean, and decidedly the coldest March yet observed, the night temperature being almost universally low, and in some instances extremely low; warmest day, 45°·5, on 4th; coldest, 25°·5, on 10th; highest in sun, 119°·4, on 8th; lowest on grass, 12°·8, on 24th; accumulated temp. above and below 42°, respectively 154 and 485 day-degrees. *Rainfall*, ·40 in. below four-year mean; the driest March yet observed; no falls of any consequence occurred; slight **S** on 7th, 10th, 15th, 16th, and 24th. *Prevailing winds*, N. and N W., with gale on 6th and 22nd from N.E. and E.

APRIL.—A quiet, dry, bright month, though becoming showery and colder towards the close; **F** 11th—14th; **H** 22nd; the commencement of the month, especially 5th, might be termed hot. *Pressure*, ·13 in in excess of four-year mean; highest, 30·66 ins., on 7th; lowest, 29·40, on 28th. Pressure remained high between 6th and 9th. *Temperature*, 0·5 in. in excess of four-year mean; warmest day, 55°·5, on 4th; coldest, 37°·2, on 23rd; highest in sun, 120°·8, on 3rd; lowest on grass, 20°·6, on 11th; accumulated temp. above and below 42°, respectively 358 and 542 day-degrees.

Temperature reached 60° from 2nd to 5th, and besides actual min. sank as low as 21°·6 on 9th on the grass. *Rainfall*, ·08 in. below four-year mean; no rain until 18th; chief falls besides max., ·29 on 18th, and ·59 on 27th. *Prevailing winds*, N. and N.E.

May.—An unsettled month, at first with low temperature; after 13th a dry period with more genial temperature and brighter skies set in, and a rainless period was only broken by **T S** on 26th. *Pressure*, ·13 in. below mean, being lower than in any previous year; highest, 30·36 ins., on 17th; lowest, 29·62, on 9th. *Temperature*, 0°·9 below four-year mean; warmest day, 61°·2, on 24th; coldest, 41°·4, on 9th; highest in sun, 131°·4, on 15th; lowest on grass, 23°·6, on 4th; accumulated temp. above and below 42°, respectively 625 and 548 day-degrees. Max. above 70°, 22nd to 25th; last trace of frost on 21st. *Rainfall*, ·17 in. in excess of four-year mean; no rain, however, fell after 13th except during **T S** of 26th; chief fall besides max., ·31 in. on 11th. *Prevailing winds*, N. and S.W.

June.—Though neither a hot nor bright month, the present, both as regards temperature and amount of sunshine, compares favourably with the corresponding month in previous years. Towards end of month **T SS** were frequent, that of 26th being especially heavy. *Pressure*, ·05 in. in excess of four-year mean; highest, 30·35 ins., on 13th; lowest, 29·76, on 7th; towards end of month disturbances were frequent. *Temperature*, 0°·4 in excess of four-year mean; warmest day, 69°·2, on 30th; coldest, 49°·9, on 17th; highest in sun, 129°·6, on 5th; lowest on grass, 33°·0, on 17th; accumulated temp. above and below 42°, respectively 1081 and 548 day-degrees. While max. reached 80° on 30th, it was only 55° on 8th. *Rainfall*, ·09 in. in excess of four-year mean; the dry period which set in on May 14th lasted until 15th of this month; chief falls besides max. ·49 in. on 20th and ·25 on 25th. *Prevailing wind*, N.E.

July.—Cold, wet, and thoroughly unsummerlike; the amount of bright sunshine was smaller even than in the two previous years, and was very small after first ten days. *Pressure*, ·07 in. below four-year mean; highest, 30·10 ins., on 1st; lowest, 29·55, on 12th. *Temperature*, 2°·4 below four-year mean, and the lowest temp. yet recorded for July; warmest day, 66°·1, on 3rd; coldest, 50°·9, on 15th; max. in sun, 132°·0, on 2nd; lowest on grass, 37°·1, on 16th; accumulated temp. above and below 42°, respectively 1580 and 548 day-degrees. Whilst the days were far from warm, the nights were decidedly cold; the highest temperature was quite at beginning of month. *Rainfall*, ·28 in. above four-year mean; the wettest July since 1880; chief falls besides max., ·30 in. on 2nd, ·28 on 13th, ·57 on 14th, ·39 on 20th, and ·53 on 21st. *Prevailing wind*, S.W. and W., fresh on 11th.

August.—At first showery and dull, after 13th the weather became more settled, warmer, and brighter, but at no time was it really hot. *Pressure*, ·13 in. above four-year mean, and the highest mean pressure for the month yet observed; highest, 30·29

ins., on 23rd; lowest, 29·55, on 10th. *Temperature*, 1°·2 in excess of four-year mean; warmest day, 65°·0, on 13th; coldest, 52°·4, on 8th; highest in sun, 129°·0, on 21st; lowest on grass, 39°·9, on 12th; accumulated temp. above and below 42°, respectively 2144 and 548 day-degrees. The commencement of the month was colder than its close. *Rainfall*, ·72 in. below four-year mean; chief falls besides max., ·26 in. on 8th and ·30 on 31st. *Prevailing winds*, W. and N.W.; blowing freshly from S.W. on 8th and 14th.

September.—With a heavy rainfall there was a fair amount of fine weather with bright sunshine. It is curious that the excess of rain was scarcely noticeable over England except in E. district, whilst in Scotland there was absolutely a deficiency. *Pressure*, ·06 in., below four-year mean; highest, 30·07 ins., on 13th; lowest, 28·87, on 2nd. *Temperature*, 2°·4 below four-year mean; warmest day, 62°·7, on 17th; coldest, 47°·7, on 6th; highest in sun, 116° 7, on 18th; lowest on grass, 37°·1, on 6th; accumulated temp. above and below 42°, respectively 2343 and 548 day-degrees; warmest period 16th—19th, during which max. exceeded 70°; max. on 15th only 57°·9, and on 6th, 29th, and 30th, only 53°·6. *Rainfall*, 1·23 in. above four-year mean, and the wettest September of the four as well as the wettest month in the year; chief falls besides max., ·53 in. on 10th, ·30 on 23rd, ·47 on 28th, ·40 on 30th. *Prevailing wind*, S.W.; gale on 2nd and 3rd.

October.—A warm and unusually quiet month, with a fair amount of sunshine; the rainfall was less than the mean by a very considerable amount, consequently it was a favourable time for autumn sowing. *Pressure*, ·04 in. in excess of four-year mean; highest, 30·40, ins. on 7th; lowest, 29·35, on 16th. *Temperature*, 2°·7 above four-year mean, being the warmest October yet observed; warmest day, 55°·9, on 27th; coldest, 41°·9, on 2nd; highest in sun, 105°·9; lowest on grass, 28°·0, on 21st and 24th; accumulated temp. above and below 42°, respectively 2609 and 548 day-degrees. The first trace of frost was on 2nd, the first four days being the coldest of the whole month. *Rainfall*, 1·66 in. below four-year mean; this mean is, however, a high one, owing to heavy rainfall in 1880 and 1882; chief fall besides max., ·38 in. on 14th. *Prevailing wind*, S.W.; gale on 4th from N.W., and on 25th from S.W.

November.—Though rain was of frequent occurrence, this could scarcely be called a wet month, and there was a remarkable absence of thick fog, consequently there was a greater amount of bright weather than we usually experience. *Pressure*, exactly equal to four-year mean; highest, 30·36 ins., on 29th; lowest, 28·93, on 6th; this was the only occasion during the year in which this station lay within the area of the lowest barometric readings. *Temperature*, 1°·4 below four-year mean; warmest day, 48°·2, on 1st; coldest, 35°·7, on 12th; highest in sun, 93°·3, on 5th; lowest on grass, 25°·6, on 14th; accumulated temp. above and below 42°, respectively 2675 and 765 day-degrees. *Rainfall*, ·09 in. in excess of four-year mean; the wet periods fell into two groups, 1st to

10th, and 15th to 25th, with rain on each day; chief falls besides max., ·34 in. on 4th and ·35 on 5th. *Prevailing wind*, S.W.; gale on 25th.

DECEMBER.—A warm dry month with a great deficiency of sunshine, and with thick wet fogs towards the close, which rendered the Christmas season damp and cheerless as far as the weather was concerned; the last glimpse of the sun for the year was on 23rd. *Pressure*, ·21 in. above four-year mean; highest, 30·59 ins., on 25th; lowest, 29·60, on 11th. *Temperature*, 0°·7 below four-year mean; warmest days, 43°·0, on 11th and 12th; coldest day, 29°·4, on 7th; highest in sun, 81°·8, on 6th; lowest on grass, 23°·4, on 8th; accumulated temp. above and below 42°, respectively 2675 and 920 day-degrees; only frost registered in stand between 5th and 10th and between 17th and 19th, after which no frost was registered even by exposed thermometer. *Rainfall*, ·57 in. below four-year mean; smallest of all in the four years by ·67 in.; **S** on 5th, 6th, 16th, 17th; **F** made measurable deposit on 25th and 26th; no falls other than max. to record. *Prevailing wind*, W., with gales on 3rd, 4th, 11th, and 12th.

XIV.

REPORT ON THE RAINFALL IN HERTFORDSHIRE IN 1883.

By the Rev. C. W. Harvey, M.A., F.R.Met.Soc.

Read at Hertford, 25th April, 1884.

Our rainfall stations remain the same in number as last year, *i.e.* 29; the gauges at work, however, are increased by two, and now number 33, the two latest additions being a third gauge at Rothamsted, where all meteorological work is known to be most thoroughly attended to, and a second at Fanhams Hall, in the Upper Lea District. It will be observed that this station lies on the watershed of the Lea and the Ash, having a gauge in each district. Two old stations, Bushey Heath and Bushey Station, do not appear, the records being incomplete. On the other hand, the two new stations mentioned in my last report, Tring and Barley, have been introduced. The former of these supplies a want long felt and frequently expressed, *i.e.* an observer in the Thame district. Much, however, generally wants more; and so I again call attention to the absence of the Brent, the Chess, and the Stort districts from our reports for lack of observers.

I have to thank very much those observers who have so kindly furnished me with the daily record of the fall at their stations. This has enabled me to enter into the particulars of some of the chief falls, and to show how far, and to what extent, their influence was felt in the several parts of the county. In this, however, I have endeavoured to confine myself within reasonable limits.

I open my report with the welcome intelligence that for the first time since 1874 the rainfall has been below the mean (1870–79), and that to the extent of 1·08 inch. I trust that after a series of wet years, the year 1883 may be the commencement of a drier series.*

Through the kindness of the compilers of the Rainfall Tables for Wilts, Norfolk, and Essex, I am again able to compare the rainfall in those counties with our own.† In Wilts 57 stations give a mean fall of 31·00 inches; in Norfolk, 29 stations give a mean fall of 27·53 inches; in Essex, 25 stations give a mean fall of 22·87 inches. In each case these figures point to a diminution in the rainfall during the past year; in Wilts the difference is nearly 12 inches, in Norfolk nearly 5 inches, in Essex nearly 4 inches, while in our own county it is a little over 3½ inches. In point of dryness the four counties range in the same order as in 1882—Essex, Herts, Norfolk, Wilts.

* Compared with the mean of a long series of years, 1883 was a decidedly wet year, though it does not appear to be so when compared with the average of the wet period of 1870–79.—Ed.

† Each of these tables gives not only the monthly totals but the daily fall at every station. I wish it were possible to publish the *daily* fall for our own county.

Distribution of Rainfall throughout the Year.—Perhaps one of the best and most concise ways of showing this is by dividing the year into quarters and also into seasons, showing the relation these bear to the mean for 1870–79.

	diff. from mean.		diff. from mean.
1st quarter	— ·02 in.	Winter months ...	+ 1·17 in.
2nd ,, ...	— 1·12 ,,	Spring	— 1·82 ,,
3rd ,, ...	+ ·29 ,,	Summer	— ·95 ,,
4th ,, ...	— 1·29 ,,	Autumn	+ ·06 ,,

By winter months I mean Jan., Feb., and Dec. 1883. The winter season of 1882–83 was as much as 2·61 ins. above the mean for 1870–79. The wet months were February and September, the fall in each representing rather more than 14 % of the whole, or together upwards of a quarter of the total fall. I have no means of judging what the rainfall in this county was previous to 1834, when our oldest existing station, Nash Mills, was established, but certainly February was by far the wettest for 50 years. I may add that September was the wettest since 1876. On the other hand, although March, usually a dry month, yielded the smallest fall, August and December gave the greatest deficit compared with the mean, each being somewhere about 4 % of the total fall; the fall of August was considerably less than half the ten-year mean, while that of December was exactly half.

The mean monthly fall differed from the mean fall of 1870–79 by the following amounts:—

	ins.		ins.		ins.
January ...	— ·21	May	— ·44	September ...	+ 1·16
February ...	+ 2·00	June	— ·03	October ...	— ·51
March ...	— ·78	July	+ ·64	November ...	+ ·32
April	— ·37	August ...	— 1·58	December ...	— 1·17

Distribution of Rainfall throughout the County.—In the two main river-basins of the Thames and the Ouse, the fall in the former was 1·31 in. below the mean, while in the latter it was ·32 in. above the mean. In the five districts into which these two greater divisions resolve themselves, whilst the Lea district showed the greatest deficiency, the Cam district alone showed an excess. In the minor districts into which these five again are subdivided the mean fall was:

		ins.			ins.
Lea ...	Lower Lea	25·66	Thame ...	Upper Thame ...	29·09
	Upper Lea	23·56		Lower Colne ...	29·33
	Mimram	26·03	Colne ...	Ver...	29·52
	Beane	28·29		Gade	29·24
	Rib	26·38	Ivel ...	Hiz	25·25
	Ash	25·23	Cam ...	Rhee	24·78

The Ver for the second year in succession experienced the greatest fall; whilst the Cam, though in excess of the mean, experienced the smallest. The greatest monthly fall was 5·00 ins., in the neighbourhood of Tring, in February and again in September; the smallest was ·54 in., at Hoddesdon, in December; this was the smallest monthly fall recorded since August, 1880.

Table I.—Hertfordshire Rainfall Stations.

River District.	Station.	Observer.	Latitude.	Longitude.	Diameter of Gauge.	Height of Gauge above Ground.	Height of Gauge above Sea-level.	
			° ′ ″	° ′ ″	ins.	ft. ins.	ft.	
Thame / Up. Thame	Tring—The Vicarage	Rev. W. Quennell	51 47 33 N	0 39 25 W	5	1 0	442	
Colne. Lower Colne	Watford—Watford House	Alfred T. Brett, M.D.	51 39 25 N	0 23 35 W	8	1 3	240	T
	,, Wansford House	John Hopkinson	51 39 45 N	0 23 40 W	5	1 0	224	T
	Rickmansworth—Moor Park	Lord Ebury	51 37 30 N	0 26 20 W	5	2 0	340	⩚
Colne. Ver	St. Albans—Gorhambury	The Earl of Verulam	51 45 20 N	0 23 0 W	6	2 6	425	
	Harpenden—Rothamsted	Sir J. B. Lawes and Dr. Gilbert	51 48 10 N	0 21 30 W	5	0 9	420	T
	,, ,, (2nd gauge)		51 48 10 N	0 21 30 W	72 × 87	0 9	420	T
	,, ,, (3rd gauge)		51 48 10 N	0 21 30 W	8	0 9	420	T
	Dunstable—Kensworth	Miss Grace Jones	51 51 30 N	0 30 0 W	5	1 0	630	B
Colne. Gade and Bulbourne.	Hemel Hempsted—Nash Mills	J. Dickinson & Co.	51 44 0 N	0 26 40 W	2	2 9	237	T
	,, Great Gaddesden	Rev. W. T. Drake	51 47 20 N	0 30 30 W	8	1 0	426	
	Berkhamsted	William Squire	51 45 40 N	0 33 30 W	8	1 6	370	B
	Tring—Cowroast	Hubert Thomas, C.E.	51 47 0 N	0 36 30 W	10	4 2	345	
Lea. Lower Lea	East Barnet—Southgate	George A. Church	51 37 40 N	0 8 0 W	5	0 6	240	T
	Hoddesdon	A. C. McKenzie	51 45 40 N	0 0 30 W	8	1 6	147	
Lea. Upper Lea	Ware—New River Company	F. Francis	51 46 0 N	0 6 0 W	12	3 0	114	T
	,, Fanhams Hall	Miss J. Croft	51 49 30 N	0 1 30 W	8	1 0	253	
	Hertford—Bayfordbury	W. Clinton Baker	51 46 30 N	0 5 30 W	8	0 4	250	
	Hatfield—Brocket Hall	Hon. H. F. Cowper, M.P.	51 48 0 N	0 14 0 W	8	1 0		
Lea. Mimram	Welwyn—The Rectory	Rev. C. L. Wingfield	51 49 50 N	0 12 30 W	5	0 4	238	T
	,, Datchworth	Rev. J. Wardale	51 51 0 N	0 10 0 W	6	1 0	386	T
Lea. Beane	Stevenage	Rev. J. O. Seager	51 55 5 N	0 11 40 W	8	2 0	319	L ⩚
	,, Knebworth	Rev. F. G. Jenyns	51 52 30 N	0 12 30 W	5	1 0	391	T
Lea. Rib	Buntingford—Throcking	Rev. C. W. Harvey	51 57 5 N	0 3 0 W	5	1 0	484	T
	Royston—Therfield	Rev. J. G. Hale	52 1 0 N	0 3 0 W	5	4 3	500	
Lea. Ash	Ware—Fanhams Hall	Miss J. Croft	51 49 0 N	0 1 0 W	5	1 0	253	
	,, Much Hadham	T. W. Mott	51 51 24 N	0 4 38 E	5	1 0	222	B
Cam. Ivel. Hiz	Hitchin	William Lucas	51 57 0 N	0 16 20 W	5	2 1	238	T
	,, High Down	Joseph Pollard	51 57 40 N	0 20 0 W	5	1 1	422	T
Cam. Ivel. Rhee	Royston	H. Wortham	52 2 34 N	0 1 8 W	8	0 6	269	⩚
	,, Odsey Grange	H. G. Fordham	52 1 28 N	0 6 41 W	5	1 0	262	
	,, ,, ,,	,, ,,	52 1 28 N	0 6 41 W	5	1 0	262	⩚
	,, Barley	Rev. C. O. Miles	52 1 0 N	0 3 0 E	5	1 0	322	

TABLE II.—SHOWING THE RAINFALL AT VARIOUS STATIONS IN HERTFORDSHIRE IN 1883.

STATIONS.	JAN.	FEB.	MAR.	APL.	MAY.	JUNE.	JULY.	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL.	DAYS.
Tring—The Vicarage	2·82	5·00	·95	1·41	2·00	1·96	2·60	·92	5·00	2·18	3·48	·77	29·09	194
Watford—Watford House*...	3·32	4·45	·88	1·63	2·24	2·26	3·91	1·04	4·01	2·54	4·41	1·32	32·01	181
,, Wansford House...	2·77	4·07	1·00	1·36	1·83	1·91	3·36	1·02	3·57	2·27	3·89	1·22	28·27	183
Rickmansworth—Moor Park	3·02	4·04	1·14	1·41	2·02	1·73	2·84	1·06	3 33	2·04	3·81	1·26	27·70	175
St. Albans—Gorhambury ...	3·57	4·84	·85	1·34	1·89	2·08	4·62	·80	3·76	2·47	3·51	1·11	30·84	167
Harpenden—Rothamsted.....	3·28	4·28	·76	1·43	1·84	2·16	4·16	·78	3·94	2·48	3·46	1·07	29·64	184
,, ,, (2nd gauge)	3·30	4·34	·88	1·48	1·89	2·23	4·21	·85	3·99	2·49	3·52	1·16	30·35	203
,, ,, (3rd gauge)	3·19	4·18	·75	1·40	1·77	2·10	4·03	·71	3·83	2·38	3·35	·92	28·61	171
Dunstable—Kensworth	3·09	4·32	·81	1·75	1·89	1·89	3·17	·91	3·83	2·44	3·08	·97	28·15	167
Hemel Hempsted—Nash Mills	3·15	4·63	·82	1·26	1·85	2·62	3·48	·78	3·95	2·20	3·74	·91	29·39	166
,, ,, Great Gaddesden	2·97	4·16	·93	1·40	2·14	2·10	3·77	·91	3·92	2·25	3·14	·90	28·59	177
Berkhamsted	3·25	4·70	1·14	1·30	2·08	2·07	2·86	·90	4·17	2·38	3·57	·94	29·36	155
Tring—Cowroast	3·13	4·87	1·09	1·33	1·97	1·92	2·88	·83	4·57	2·53	3·78	·87	29·77	143
East Barnet—Southgate	2·37	3·55	1·09	1·76	1·81	2·08	3·44	1·22	4·29	2·28	3·65	1·04	28·68	176
Hoddesdon	1·92	2·63	·59	2·29	1·51	1·15	3·25	·90	3·73	2·07	2·33	·54	22·91	104
Ware—New River Company	1·88	3·30	·84	1·45	1·29	2·30	2·48	1·65	3·09	1·60	3·04	1·04	23·96	117
,, Fanhams Hall.....	2·03	3·80	1·09	1·70	1·62	2·21	2·74	1·11	3·68	1·85	2·96	·97	25·76	158
Hertford—Bayfordbury	2·06	4·00	·81	1·66	1·45	1·72	2·57	·84	3·54	1·75	3·15	·96	24·51	157
Hatfield—Brocket Hall † ..	1·71	3·12	1·42	1·78	·82	1·40	1·98	·73	3·59	1·49	1·37	·63	20·04	...
Welwyn—The Rectory	2·27	3·75	·90	1·67	1·73	1·65	3·22	1·34	3·36	1·95	3·07	1·05	25·96	189
,, Datchworth.....	1·77	3·46	·83	1·72	1·78	1·91	3·95	1·06	3·55	1·97	2·90	1·20	26·10	170
Stevenage	1·89	3·54	·83	1·75	1·82	1·97	4·33	·98	3·60	2·13	3·08	1·06	26·98	164
,, Knebworth	2·44	4·12	1·11	1·74	1·82	1·93	5·16	·88	3·70	2·13	3·25	1·32	29·60	172
Buntingford—Throcking.....	1·75	3·55	·64	1·79	1·16	2·20	3·44	1·64	4·04	2·02	2·71	1·01	25·95	169
Royston—Therfield	1·57	3·40	·83	2·07	1·32	3·87	3·04	·97	4·26	1·82	2·52	1·14	26·81	157
Ware—Fanhams Hall	2·33	3·45	·81	1·68	1·48	2·20	2·34	1·60	2·80	1·68	2·75	·88	24·00	157
,, Much Hadham.....	1·82	3·96	1·04	1·78	1·50	2·63	2·84	1·24	3·15	1·84	3·16	1·50	26·46	169
Hitchin	1·91	3·79	·75	1·67	1·73	2·08	3·56	·80	3·52	1·87	2·80	·93	25·41	176
,, High Down	2·13	3·66	·69	1·69	1·76	2·05	3·45	·89	3·28	2·16	2·66	·85	25·27	164
Royston	1·51	3·26	·81	2·07	1·20	5·11	2·70	1·00	4·26	1·74	2·64	1·07	27·37	163
,, Odsey Grange.....	1·13	2·36	·65	2·06	1·41	2·81	2·74	1·19	4·06	1·52	2·04	·80	22·77	184
,, Odsey (2nd gauge)...	1·24	2·29	·73	2·20	1·40	2·80	2·82	1·21	4·07	1·50	2·09	·81	23·16	178
Barley	1·14	3·08	·71	2·28	1·26	4·99	2·46	·96	3·80	1·78	2·38	1·12	25·96	160
Mean for the County	2·36	3·82	·88	1·68	1·68	2·31	3·28	1·02	3·79	2·05	3·07	1·01	26·95	164

* This return seems too large compared with those of neighbouring stations. † This seems too small.

TABLE III.—SHOWING MEAN MONTHLY FALL IN THE RIVER DISTRICTS.

River District.	January.	Difference from mean 1870-79.	February.	Difference from Mean 1870-79.	March.	Difference from Mean 1870-79.	April.	Difference from Mean 1870-79.	May.	Difference from Mean 1870-79.	June.	Difference from Mean 1870-79.
Thame	2·82	— ·04	5·00	+3·27	·95	— ·76	1·41	— ·77	2·00	— ·36	1·96	— ·28
Colne	3·16	+ ·36	4·42	+2·35	·91	— ·84	1·42	— ·76	1·95	— ·27	2·09	— ·31
Lea	1·99	— ·41	3·54	+1·80	·91	— ·71	1·77	— ·15	1·51	— ·52	2·09	— ·26
Ivel	2·09	— ·13	3·56	+1·97	·72	— ·76	1·68	— ·27	1·74	— ·24	2·06	— ·07
Cam	1·47	— ·49	2·75	+1·16	·72	— ·70	2·15	+ ·47	1·32	— ·58	3·93	+1·80

River District.	July.	Difference from Mean 1870-79.	August.	Difference from Mean 1870-79.	September.	Difference from Mean 1870-79.	October.	Difference from Mean 1870-79.	November.	Difference from Mean 1870-79.	December.	Difference from Mean 1870-79.
Thame.....	2·60	— ·24	·92	—1·84	5·09	+2·24	2·18	—1·80	3·48	+ ·52	·77	—1·59
Colne	3·61	+ ·83	·88	—1·89	3·91	+1·20	2·37	— ·47	3·61	+ ·72	1·05	—1·24
Lea	3·19	+ ·70	1·16	—1·25	3·59	+ ·99	1·90	— ·35	2·85	+ ·20	1·17	— ·91
Ivel	3·50	+ ·80	·93	—1·34	3·39	+ ·92	1·93	— ·24	2·73	+ ·13	·89	—1·16
Cam	2·68	+ ·57	1·09	—1·23	4·05	+1·69	1·63	— ·27	2·29	+ ·01	·95	— ·95

Mean annual fall in 1883 in Thame District 29·09 ins. being ·18 *below* mean of 1870-79.
,, ,, ,, Colne ,, 29·38 ,, ,, ·21 ,, ,, ,,
,, ,, ,, Lea ,, 25·53 ,, ,, 1·04 ,, ,, ,,
,, ,, ,, Ivel ,, 25·25 ,, ,, ·41 ,, ,, ,,
,, ,, ,, Cam ,, 24·78 ,, ,, 1·19 *above* ,, ,,

The absolute maximum fall in 24 hours in each month with the date and station at which it occurred was:

		in.			in.
Jan.	15th—Gorhambury	·94	July 14th—Knebworth		1·81
Feb.	10th—Brocket Hall... ...	1·36	Aug. 3rd—Ware		·70
March	23rd—Brocket Hall... ...	·51	Sept. 29th—Tring		1·50
April	28th—Royston	·82	Oct. 14th—Hoddesdon		·62
May	26th—Great Gaddesden ...	·72	Nov. 5th—Hoddesdon		·66
June	25th—Royston...	1·98	Dec. 10th—Moor Park		·53

The maximum fall of the year, 1·98 in., was the heaviest fall which has occurred since the 14th of September, 1880, when upwards of 2 inches fell at Nash Mills and at Moor Park. It was this fall which no doubt caused the excess in the Cam district before alluded to. The fall on January 15th, which yielded over ·50 in. in S.W., was scarcely perceptible in N.E. On Feb. 10th the fall varied from $\frac{1}{2}$ to $\frac{3}{4}$ of an inch at most stations; at the Cowroast it reached an inch. On March 23rd no rain fell at any other station. On April 28th, though heavy at all stations except Gorhambury, where there was no fall, the rain was heaviest in N.E. On May 26th, though pretty much the same at all stations, the fall was least in S. and E. On June 25th the fall was the result of a very partial **T S**, heaviest in E. and N.E., where the fall exceeded an inch, while in S. and S.W. it was in many instances almost nil; ·42 in. and ·50 in. fell at Gorhambury and Datchworth, while at Great Gaddesden no rain was gauged. On July 14th a **T S** was pretty generally felt, though heaviest in the neighbourhood of Stevenage. On August 3rd there was a very partial **T S**, no rain falling at any station except ·70 in. and ·40 in. at the two Ware stations, ·41 in. at Throcking, ·19 in. at Odsey, ·09 in. at Hadham, and ·04 in. at Therfield. On Sept. 29th, the wettest day of the year, the mean fall at all stations was ·93 in. ranging from 1·50 in. at Tring to ·48 in. at Southgate, and exceeding an inch at eleven stations.

An analysis of the wettest days in each month gives the following result:—

Jan. 15th at 15; 24th at 5; 25th at 4; 28th at 1; 29th at 4.
Feb. 2nd at 7; 8th at 3; 10th at 19.
Mar. 7th at 1; 19th at 26; 23rd at 1; 30th at 1.
April 18th at 11; 27th at 2; 28th at 15; 29th at 1.
May 11th at 12; 12th at 1; 26th at 16.
June 10th at 1; 15th at 13; 20th at 4; 22nd at 1; 25th at 7; 26th at 1; 29th at 2.
July 14th at 13; 17th at 1; 20th at 5; 21st at 4; 23rd at 3; 31st at 3.
Aug. 3rd at 3; 6th at 1; 8th at 13; 30th at 1; 31st at 11.
Sept. 10th at 1; 29th at 28.
Oct. 13th at 1; 14th at 20; 15th at 5; 25th at 3.
Nov. 4th at 2; 5th at 15; 13th at 1; 22nd at 3; 24th at 2; 25th at 1; 30th at 4; 31st at 1.
Dec. 2nd at 1; 10th at 22; 16th at 5; one station no return of max. fall.

The wettest day in each month appears to have been:

January ...	15th	April ...	28th	July ...	14th	October ...	14th
February	10th	May ...	26th	August ...	8th	November	5th
March ...	19th	June ...	15th	September	29th	December	10th

On the days of max. fall the following falls of an inch or more were gauged:—

Feb. 10th, Cowroast, 1·00.
June 25th, Hadham, 1·18; Barley, 1·66.
July 14th, Rothamsted, 1·14; Datchworth, 1·17; Stevenage, 1.07.
Sept. 29th, Kensworth, 1·11; Great Gaddesden, 1·09; Berkhamsted, 1·10; Cowroast, 1·45; Bayfordbury, 1·02; Datchworth, 1·01; Throcking, 1·20; Therfield, 1·10; Royston, 1·05; Barley, 1·22.

Other falls of an inch or more which occurred on days other than the days of max. fall, were :—July 17th, Hoddesdon, 1·10; 23rd, Knebworth, 1·00; 31st, Gorhambury, 1·22.

On July 17th the fall was very local, Hadham, ·42 in., being the only station beside Hoddesdon recording any fall of consequence, whilst 13 stations record no rain at all. On July 23rd, though rain was generally felt at all stations, except Hadham, where nothing was gauged, the fall was heaviest in the neighbourhood of Stevenage. The only other fall which calls for particular notice was that of June 29th, a **T S**, when although ·80 in. was gauged at Nash Mills, nothing was gauged at Gorhambury or at Rothamsted.

The mean number of wet days in each month and the relation that number bears to the mean of 1870–79 was:

Jan.	wet days	20,	or	4 above	mean.	July	wet days	16,	or	3 above	mean.
Feb.	,,	14	,,	1 below	,,	Aug.	,,	11	,,	3 above	,,
Mar.	,,	9	,,	5 below	,,	Sept.	,,	16	,,	3 below	,,
Apr.	,,	9	,,	4 below	,,	Oct.	,,	14	,,	1 below	,,
May	,,	10	,,	3 above	,,	Nov.	,,	19	,,	3 below	,,
June	,,	12	,,	2 above	,,	Dec.	,,	13	,,	2 below	,,

While the mean number of wet days was only slightly in excess in the winter months, there was a decided excess in the summer, and as decided a deficiency in the spring and autumn months. Of the heavy falls that of Sept. 29th was the most general. Falls exceeding an inch fell in 4 months, *i.e.* Feb., June, July (4 days), and September, or on seven different occasions.

XV.

ON INSTINCT.

By F. Maule Campbell, F.L.S., F.Z.S., F.R.M.S.

Read at Hertford, 25th April, 1884.

The human mind is the only instrument we can employ to investigate analogically the actions of animals. There is, however, no reason why we should introduce into this enquiry any greater amount of such reasoning than is necessary. Ordinary language is sufficient to place us on our guard against this error. The female spider is considered to act "paradoxically" in devouring her consort,* because in doing so she conflicts with human sentiment. But her conduct is in accordance with what we ought to expect from a creature of non-gregarious habits which feeds mostly upon forms of life weaker than itself. A dog is called "clever" if able to perform tricks which could be of no possible use to him in a wild state; while a high canine intelligence, suitable to his natural wants, is frequently left unascertained, or, if it be ascertained, is only valued so long as it administers either to the advantage or pleasure of humanity. The domestication of animals has entirely changed their habits and course in life. At one time they were chiefly occupied in obtaining food, while now their energies are diverted to rendering service to man, on whom their happiness is dependent. These new conditions are almost equal to a new phase of existence, even though man, in consulting his own convenience, has chosen for the change those most suitable to the animal. New habits and instincts have been developed, and we may be sure that some old ones have been weakened or lost. Having thus placed some animals in an artificial state, we apply artificial tests of intelligence not only to them but to others still enjoying freedom. The better plan is to draw our conclusions from adjustments which are related to an animal's own habits, and which are due to its own observation. We are thus enabled to form some idea of its natural capacity.

Intelligence differs from reason, not in kind but in degree; and the clearest evidence of its possession by animals lies in their profiting by experience. My dog, when quite a puppy, saw me put on a bee-veil, and followed me to my apiary. He was soon badly stung. Since that day he has discreetly retired whenever he has seen me in my bee-dress. On my return to the house he looks at me from head to foot, and should he see a bee withdraws to a respectful distance. He avoids a flying bee, but snaps at a blue-bottle, and thus shows a recognition of the difference between the two buzzes, forms of flight, or odours, and of the inference to be thence drawn. If he wants to enter a room, and the door is shut, he will generally jump up at the handle. The direction of his eyes and the position of his paws will show plainly that his object is not merely to *push*

* See my remarks on this subject in "The Pairing of *Tegenaria Guyonii*, Guér." —'Journ. Linn. Soc.,' Zool., vol. xvii, p. 162.

the door open, but that he considers some action on the handle is requisite to effect the opening; or he will jump at the door and wait for a few seconds as if he wanted a response. Similar actions of domestic pets and animals occur in every household. There are, for instance, few dogs or horses in establishments where the daily practices are different on Sundays who do not show by their conduct a recognition of the change which has never been taught them. Christmas Day, Good Friday, come round, and the usual Sunday occurrences are repeated. The indications may be the hour of rising, of breakfasting, of performing some daily work, the change of dress, the silence of the early morning, or some unsuspected detail; but, whatever they are, the animals show that they note them, and know what will be expected of them on that day. In the same manner, where the habits of a kennel and stable are regular, dogs know when they are going shooting, and hunters and hounds when they are going hunting. I know of a cat in Devonshire Square, City, who wilfully absents himself on Saturday afternoons, when his home, which is a warehouse, is deserted and closed, until Monday. He spends this time as a welcome guest in the kitchen of the next house.

The more we know of animals, the more we see that they profit by experience. Many ascribe this adaptive action to Instinct—a word which has been so frequently misapplied as to have made many wish that it could be erased from the dictionary. Indeed, it would seem that many regard intelligence as the monopoly of humanity, and, as they cannot indict animals for infringement of right, attribute the manifest signs of its co-possession to some other faculty. There can be no doubt that the use of the word Instinct would never have become so general were it not for the apparent, though not real, anomaly of animals showing the most remarkable adjustments, whether as structures or as actions, side by side with incapacity under some conditions. The general admission of inherited aptitudes with tendencies to variation in the lower animals, as well as in men, and "the survival of the fittest," have dispelled the mystery formerly attached to the word. Scientific men believe that the phenomena included under the term "Instinct" have been as gradually developed during many generations, as our own greatest inventions, which, if seen without a knowledge of their history, would strike us with the wonder frequently expressed at the sight of the waxen comb of the hive-bee. Darwin says that he "will not attempt any definition of Instinct," and he adds, "every one understands what is meant when it is said that instinct impels the cuckoo to migrate, and to lay her eggs in other birds' nests. An action which we ourselves require experience to enable us to perform, when performed by an animal, more especially by a very young one, without any experience, and when performed by many individuals in the same way, without their knowing for what purpose it is performed, is usually said to be instinctive. But I could show that none of these characters of instinct are universal."*

* 'Origin of Species,' 6th ed., p. 205.

Definition of Instinct.

Romanes has defined Instinct as "reflex action into which there is imported the element of consciousness. The term is therefore a generic one, comprising all those faculties of mind which are concerned in conscious and adaptive action, antecedent to individual experience, without necessary knowledge of the relation between means employed and ends attained, but similarly performed under similar and frequently-recurring circumstances by all the individuals of the same species." * The same author writes : "The most important point to observe in the first instance is that instinct involves *mental* operations; for this is the only point that serves to distinguish instinctive from reflex action. Reflex action is non-mental neuro-muscular adaptation to appropriate stimuli; but instinctive action is this and something more; there is in it the element of mind. No doubt it is often difficult, or even impossible, to decide whether or not a given action implies the presence of the mind-element—*i.e.* conscious as distinguished from unconscious adaptation; but this is altogether a separate matter, and has nothing to do with the question of defining instinct in a manner which shall be formally exclusive, on the one hand of reflex action, and on the other of reason. As Virchow truly observes, 'it is difficult or impossible to draw the line between instinctive or reflex action;' but at least the difficulty may be narrowed down into deciding in particular cases whether or not an action falls into this or that category of definition; there is no reason why the difficulty should arise on account of any ambiguity of the definitions themselves. Therefore I endeavour to draw as sharply as possible the line which *in theory* should be taken to separate instinctive from reflex action; and this line, as I have already said, is constituted by the boundary of non-mental or unconscious adjustment, with adjustment in which there is concerned consciousness or mind." †

Most naturalists would be satisfied with the rough sketch of the meaning of "Instinct" as given in the chapter containing the sentence already quoted from Darwin, and it is in this sense they have hitherto applied it. But it is this very use of the word that renders a definition necessary to the psychologist when discussing mental evolution, should he decide to retain it. All definitions are inherently faulty, and particularly those of psychical characteristics; inasmuch as any attempt to separate such characteristics impairs the individual existence, in which alone they are recognisable. Evidently the definition must be theoretical, as Romanes admits. The limitation of the meaning of any word increases the difficulty of its application. But in the case of "Instinct" there is more than this. The very definition given by Romanes precludes observers from being sure that they are correct in employing it. This cannot be said of "Intelligence," the evidence of the possession of which is the profiting by experience or the adaptation to new conditions. There is however no such test of "Instinct" as defined by Romanes. For if an instinctive act be not modified perceptibly to an observer

* 'Mental Evolution in Animals,' p. 159. † *Ib.*, p. 160.

by the mental element, it is undistinguishable from a reflex act, which is frequently performed by all members of the same species. If it be so modified, it is undistinguishable from reason. This observation is perfectly reconcileable with a general acceptance of the theoretical definition given by this distinguished writer. Psychology necessarily admits of a greater use of subjectivity than is required by an observer of natural phenomena; indeed the less of this he introduces into the object under contemplation, the nearer he will be to truth. Before entering further into this matter, I will touch briefly on reflex action, for I fear that "non-mental neuro-muscular adjustment" may not be an intelligible definition to some of our members.

We may conveniently confine the term Reflex Action to animals which possess nerves and muscles, although the phenomena exhibited by such sensitive plants as Venus' fly-trap and the sensitive *Mimosa* differ in hardly any respect from reflex action, for we have in these—an acting stimulus, a latent period, and a response in the form of movement—phenomena which cannot be distinguished from reflex action. In all reflex action there is an exciting cause and a movement, as well as a constant relation between the two which has been established by the individual itself or by its ancestors. I am aware that secretion is regarded by some as a reflex action, but bearing in mind the present state of science, and for the sake of simplicity, I have excluded cases of secretion. Had I chosen to include them, they would not have modified my conclusions, though they might have led me to widen the definition of reflex action. A sucker of a limb of an octopus which is separated from the body will adhere to a solid substance through the action of its own nerve-ganglion.* The same principle is involved when a man who is so paralysed that he has no feeling in his legs, moves them when his feet are tickled.

Our own experience tells us how easily some actions acquired with much difficulty come to be performed unconsciously after having been often repeated. Such acts frequently take place as the result of some occurrence which has habitually preceded them. We may walk about the room deep in thought, when suddenly we stop and find immediately in front of us a chair with which another step would have brought us into collision; yet when we stopped we were quite unconscious of anything being in our way. There was, in fact, an established relation between an object before us, the optic nerve, and the mechanism employed in arresting our movement. An impulse was carried by the optic nerve to a nerve centre or centres, and was there transmuted into fresh impulsions along the nerves in connection with the numerous muscles used in our action of stopping. The optic nerve had so frequently received similar impulses, and conveyed them to its nerve-centre, that the latter knew what to do with them without appealing for direction to a higher controlling power, viz. a higher nerve-centre. The limits of my paper prevent me from entering into the many forms and the combinations of

* See H. Spencer's 'Principles of Psychology,' p. 428.

these unconscious actions, or doing more than point out the frequent cases of children inheriting from their parents, or indeed from some more remote ancestor, little habits or nervous tricks which are performed unconsciously and are frequently most difficult to control.

I will now continue my remarks on "Instinct" as exhibited in animals with nerves and muscles. In this relation an interest is attached to the first appearance of such structures in the animal kingdom. The motion of some of the Infusoria leads to the suspicion of their possessing nerve-fibres, and Engelmann entertains their presence in *Stylonychia mytilus*.* But it is only in the jelly-fishes that a nerve-structure and organs of a special sense, viz. sight, are generally accepted as first occurring. I cannot, however, help thinking that this instance of nerve-structure is more complex than might have been expected under the circumstances. Romanes has studied these creatures, and found, by irritating the surface of the umbrella in some species, that the stick or manubrium was raised to the spot as if to remove some particle which had rested there, but he attributes this to reflex action.† He says that the Cœlenterata "present no semblance of evidence that any of their responsive movements are of a perceptive, or even of a conscious nature." ‡ The neuro-muscular structures of the Echinodermata (star-fishes) are more highly developed, and "the 'acrobatic' and righting movements . . . . are, to say the least, strongly suggestive of true powers of perception." § Let us then take the Echinodermata as a typical case of difficulty, and ask the question, Would an observer be justified in stating under any circumstances that these actions were instinctive? We cannot state that consciousness is always co-existent with nerve-structure. Morphology entirely fails in attempting such an analysis. All we know is that consciousness is located in the highest nerve-centres. Theoretically we may associate it with a confusion of impulses in a complexity of ganglia, but of this there is no proof. If, however, we have ascertained by careful observation that an animal has performed an intelligent action, we can credit it with consciousness, for that is the basis of all mental faculty. An intelligent action is the intentional adaptation of means to ends. But the intention, even in another human being, is not so easily ascertained. Adjustment to new conditions is a satisfactory test, but the difficulty arises of being sure that they *are* new, and that the adjustment is not an accidental application or modification of an old habit. The best evidence is the profiting by experience. Let us suppose, for argument's sake, that we have satisfied ourselves by this latter means that the Echinodermata are intelligent, and therefore are conscious. We should still not be justified in describing any particular action of an individual as associated with the mental element; and if not associated with the mental element, according to the definition of Romanes, it would not be instinctive. If the illustration I gave of a reflex action, viz. unconsciously stopping in front of a chair while walking

* Pfluger's 'Archive. Phys.,' Band xxiii, 1880, p. 530.
† 'Mental Evolution in Animals,' p. 83. ‡ *Ib.*, p. 348. § *Ib.*, p. 348.

across the room, be turned into one of intelligence, we should simply state that we observed the chair, and that we studied each step with a view of avoiding it. Nay, more, if we wished to adapt the illustration to the definition of an instinctive action, we should say that we had a distinct perception of the chair being in our way, but that we necessarily avoided it as the result of inherited or of acquired organisation. But to an observer our action in the three cases would be the same. If this be true of the human being, surely it is also true of the Echinodermata of which I have just spoken. Some indication of the nature of the action is offered by the absence of hesitation with which it is performed. Perception requires time, just as consideration implies deliberation, and all action is quicker if independent of consciousness. We start on the sudden occurrence of a noise, and our perception of it is too late for us to inhibit the reflex movement. But the test of promptitude when applied to animals requires great knowledge of their habits.

Further, it would appear that the word Instinct is applied to very different degrees of inheritance. This is exemplified by the cuckoo and the web-spinning spiders. The cuckoo inherits an impulse to lay its egg in another bird's nest, but it rests with the individual cuckoo to find the nest it requires, and the circumstances under which it is found depend on the individual ability of the bird. On the other hand, the spider inherits the skill of execution as well as the impulse of web-construction. In the one case the inheritance of the instinct is related to a corresponding modification of the organism, in the other, viz. that of the cuckoo, there is no special modification of structure on which the instinct depends. We may regard it, if we please, as mere idleness. Domestic hens frequently lay in other hens' nests, whether or not they have a nest of their own, either from carelessness or idleness. The same occurs among partridges. The yellow-billed cuckoo (*Cuculus Americanus*, Linn.), according to Audubon, constructs a nest for itself, but occasionally lays in the nest of another bird.* Even in these cases we must be cautious before we say there is no inherited modification of structure concomitant to the instinct, for we do not know that cuckoos moult the feathers on the abdomen, which would render them unfit for brooding, and it may be that some peculiarity in which the ova are developed determines the instinct. It is the old story;—Which comes first, the structure or the function? Further, if the impulse of the cuckoo be considered instinctive, it is difficult to see why we should not apply the same term to the inherited aptitudes of humanity. The inheritance of special proclivities has been amply shown by F. Galton in 'Hereditary Genius,' and if we accept Romanes' definition of Instinct as distinguishable from Reason, it seems impossible to draw the line between certain intelligent actions of man and the instinctive actions of other animals. It also appears that the application of the term Instinct requires some limitations in the case of actions which are performed by members of one species. Dogs admittedly belong all to one species, but the instincts of a

* Morris, 'British Birds,' vol. ii, p. 43.

terrier, Newfoundland, and retriever, are very different. Even if the term "race" or "variety" be substituted for "species," there is no evidence that every individual of a particular race exhibits the characteristic instinct to the same degree, or, indeed, at all. Some pointers fall in at once with the habit which distinguishes pointers, while others are so difficult to train that the effort is abandoned.

The preceding observations as to the use of the word "Instinct" may be summed up as follows, viz. that it is impossible for an observer to designate with accuracy any particular action of an animal as reflex, or instinctive, or intelligent. At the same time it will be admitted that when an individual shows that it has profited by experience, it may justly be said to have acted intelligently. The term "Instinct" has however been generally employed by naturalists without any psychological distinction to express actions which are common to a species, and their so doing has in no case led to confusion. For this reason, although the limitation is by no means accurate, it is best to retain the term. But it is very advisable that naturalists should know the meaning attached to "Instinct" by psychologists, and for that reason I give the following analysis, wherein I have endeavoured to express the view of Romanes, or at any rate my own.

I. Unaccompanied by mental activity—Reflex action.
II. Accompanied by mental activity—
    (1) Common to the species—Instinct.
    (2) Peculiar to the individual—Intelligence.

Certain adaptations occurring in the vegetable kingdom, if we could believe them to be accompanied by consciousness, differ in no material degree from instinct in animals. The tree which survives the change of direction of its source of nourishment, according as its leaves become more abundant in an open space, and fewer on the side which is more confined, or the bud which gives either roots or leaves, or the oat-like grass (*Arrhenatherum avenaceum*) with its fibrous roots in damp places and its tubers in dry soils, may be taken as illustrations of my meaning. The protoplasmic amœba, which may be said to be but the common elementary basis of organic bodies, and is in appearance but a particle of mobile jelly, avoids objects, selects its food, and is capable of both automatic and excited movements, which are due to the discharge of protoplasmic energy. Nor is vegetative adjustment confined to plants. There is its physiological counterpart in animals. As we approach higher organisms, we cannot fail to notice processes so similar to adaptive action that it is difficult to ignore the fundamental relation between them. Thus, for instance, if a limb be broken and be badly set, so that two of its portions form an angle, the "vis medicatrix naturæ" not only joins the fracture, but places a bone in the angle, just as a carpenter would do with two pieces of wood in the same position, or as a sempstress would make a gusset in a garment to strengthen it. We may call these remedial phenomena the result of inflammation, but the fact remains. To carry the thought further, we will take the following case. The

other day I was watching a spider (*Tegenaria Guyonii*, Guér.) lay its eggs, when it occurred to me to see what it would do if I removed them. This I did with a lifter, somewhat to the disturbance of the mother. After a few seconds she busily commenced to spin over the spot where she had just placed her eggs, and completed her cocoon. It may truly be said that the habit of the species as to the form of the cocoon was so great that she might have been expected to proceed with it after she had deposited her eggs, even if she had missed them. There is, however, a physiological aspect to the act as well as a psychical. The maturity of the eggs may have been co-related with the greater activity in the collection of fluid by the spinning-glands; and as is the case with the mammæ of a vertebrate, the discharge of their contents may have been a necessity for the comfort of the creature.

It is clear that we cannot shut out physiological conditions from the study of instinct, and while we admit a subtle relation between vegetative processes and adaptive action, we do not know its character, nor do we satisfy any enquiry as to development. We only assert the unity of Nature's phenomena.

Relation of Evolution to Instinct.

I will now make a few remarks on the relation of evolution to Instinct, and will then proceed to the consideration of some other interesting points. It must be admitted that natural selection has largely influenced the development of those habits which are beneficial to a species, and therefore has much to do with the formation of instinct. The existence of any species shows that it possesses some advantage, humble though it be, which enables it to survive. The advantage may be its diminutive size, or its rapid reproduction, so that it only requires more simple conditions than others to support its life, and occupies as it were a corner in the world from which no other creature can quite displace it; but whatever the species may be, the effect of the struggle for existence favours the further development of the particular characteristic in which it already most excels, wherever advantage may acrue from such further development, whether mental or structural. Man has so many occupations, and his cerebral complexities give rise to so many combinations, that inheritance has little chance of specialising beneficial habits. The wants of the lower animals are however few, and their occupations are those of obtaining food by direct means, of reproduction, and of protection. Any special structure or habit which more than others advances these ends has a greater opportunity of being developed. The tendency of natural selection is to improve, even to the neglect of others, that characteristic which brings the best result. Every animal has to work for its daily bread, and throughout the whole history of a species or variety it was obtained in the way which was the easiest under the circumstances of the environment and the individual variation. Further, natural selection operates differently on each species. Thus, for instance, the varied and more elaborate webs of the spiders which build out of doors in the open, as compared with those spiders which are found in sheltered places, may be as much due

to their frequent destruction and consequent renewal as to the necessities of the situation. A species such as the garden-spider (*Epeira diadema*, Blackw.), which is continually making webs, offers greater opportunity for the development of dexterity in construction than one like the house-spider (*Tegenaria Guyonii*, Guér.), whose snare is uninjured by the prey, and lasts for months if undisturbed. The condition of its web is indeed so unimportant that the spider will take possession of a dirty abandoned tenement of another of the same species as readily as a whelk will an empty shell.

Instincts of Neuter Insects.

It must be admitted that the development of habits and structure of neuter insects, such as seen amongst ants and bees, cannot be traced in the present state of our knowledge. The most that can be done is to show that there is no anomaly. If we take, for an instance, the neuter-bee, we find a cell-maker and a pollen- and honey-collector with its second * and third pair of legs specially adapted for the purpose. The drone and the queen—its parents—have neither the structure nor the habits, and it would therefore appear as if selection could not have acted through them. I have noticed, however, that there is a variation in the tibia and first tarsal joint of the third pair of legs amongst queens and drones, and these are the parts specially adapted in neuters for the collection and conveyance of pollen. The variation consists more especially in the convexity of the tibial joint, and the dimensions of its two extremities, quite independent of the size of the queen. The origin of secondary sexual characters may be due to physiological correlations, and, if this be so, there is no reason why there should not be secondary neuter characters. These may have been developed into their present form by natural selection. The larvæ certainly receive less food than the perfect insects. Darwin's hypothetical explanation of the specialised instincts and structures of neuters is, that "selection may be applied to the family as to the individual," illustrating the idea as follows:—"Such faith may be placed in the power of selection that a breed of cattle always yielding oxen with extraordinarily long horns could, it is probable, be formed by carefully watching which individual bulls and cows, when matched, produced oxen with the longest horns, and yet no one ox would have propagated its kind."† The difficulty to many in accepting the above suggestion as applicable, is the *degree* of specialised habits for which it is supposed to account in the neuter insect, but the degree is a secondary matter, explained by the operation of natural selection, when once we can reconcile structure and a corresponding habit appearing persistently in certain offspring, and which are not to be found in the parents. If this difficulty be surmounted, the rest is clear, for the queens of the hives in which the workers are best adapted for the collection of honey and pollen, leave a greater progeny both of drones and queens than are bred in hives with

* I refer to the spur on the tibia.

† 'Origin of Species,' 6th ed., p. 230.

inferior workers. Neuter-bees are great robbers; the weaker hives are pillaged, the breeding in them is checked, and in the end they are eliminated. The most daring marauders in such expeditions may be killed, but their death affects the development of the species to a very much less extent than in the case of animals which might be expected to leave offspring. So long as a hive is strong, the queen-bee can propagate her race in security. The loss to the species by the death of a neuter-bee is but that of an individual in a working community, but the loss to the species by the death of a breeding-animal which excels in a particular characteristic, is the reduction of the number of the fittest individuals upon whom the further development of the species is dependent. Any little advance in the habits of a hive has a greater effect than is usual with an ordinary animal, which does not live in a community, and does not rob other communities of its species of stores necessary to their existence. A weak individual may escape attack by concealment, but a hive is an open treasure, and, if weak, is certain to be robbed and die out, where there is no bee-master. Thus we see that the "survival of the fittest" is very quickly realised amongst communities which rob one another, and this is doubtless the main cause of the development of special aptitudes amongst ants as well as bees. In other words, there is no reason why natural selection should not act upon a community as it acts upon an individual. The community becomes, as it were, individualised.

There is but little to be suggested in connection with the development of the cell-making instinct of the hive-bee, more than is contained on that subject in the eighth chapter of the 'Origin of Species.' Darwin there remarks that "in the series between the extreme perfection of the cells of the hive-bee and the simplicity of those of the humble-bee we have the cells of the Mexican Melipona," so that if we believe that bees had a common progenitor, we can understand how "the most wonderful of all known instincts can be explained by natural selection having taken advantage of numerous successive slight modifications of simpler instincts."

Feigning Death and Injury.

I have already touched on the relation existing between physiological conditions and "Instinct." These conditions are sometimes well adapted to a special set of circumstances. For instance, the effect of fear acting on the nervous system is partial or entire paralysis, and the still position which it entails is frequently of great advantage in the presence of an enemy. I referred to this subject in my paper "Observations on Spiders," * but I did not then enter upon the development which might arise from this physiological condition. It is possible that this fright-paralysis, called by Preyer "Kataplexy," † is the origin of the habit usually called "shamming death," and so frequently seen in animals. Let us suppose an insect to have been at times thus only partially

* 'Trans. Herts Nat. Hist. Soc.,' 1879-81, Vol. I, p. 46.

† See 'Sammlung Physiologischer Abhandlungen,' 2nd ser. 1st part, 1878.

affected by fright, and, though motionless, to have retained sufficient consciousness to have observed that its enemy passed by unheedingly. It may afterwards have so frequently and unintentionally repeated the attitude that the passive state became habitual in presence of danger. Or again, the apparent device might be developed (and I think with greater probability) totally irrespective of intelligence, by the many ancestral or individual occasions of fright-paralysis diminishing in intensity in proportion to their recurrence. Fright would soon be reduced to anxiety, or cease altogether, and the still position would become gradually the reflex of a sudden occurrence, and only historically related to paralysis. But supposing the possession of the highest intelligence, it would well be a question whether or not the best thing for a creature to do, if it did not know where to run, was to remain still.

This habit of feigning injury is highly developed in the humming-bird hawk-moths. If one of them be confined, and when quiet be tipped on to its back, it will move headforemost so slowly and steadily that it will appear on a cursory glance to be stationary. Should the moth rest more on one side than on the other, it will continue so and will not attempt to balance itself more evenly. The movement seems to be due to the almost imperceptibly rapid vibration of the fore-wings. The other limbs are all motionless, and the moth looks like a moving corpse, but it can right itself at any time.

Analogous to the practice of "shamming death" is that of "feigning injury," which is a common act of some birds (partridges, peewits, and ducks). They thus draw a pursuer away from the nest and their young. The two expressions are of course purely subjective; indeed, in the one case the still attitudes are totally unlike those of death, and in the other case the instances of wounded birds cannot so frequently occur as to offer patterns for imitation, inasmuch as maimed animals soon fall victims to their carnivorous enemies. There is also the fundamental objection that, if the animal kingdom, apart from man, shows such ratiocination as is implied by both terms, the members of it possess an intelligence almost, if not quite, equal to that of humanity. Darwin suggested as an explanation that "a female bird which, from solicitude for her nestlings, would endeavour to fight a threatening quadruped as a hen does a dog, might, by alternately attacking and retreating, inadvertently draw the enemy away from the nest. Natural selection, acting on this primitive habit, might then develope the running away from the nest as an instinct; and if, as is probable, carnivorous quadrupeds would be more likely to follow birds unable to fly than birds apparently well, the action of drooping the wing, etc., might have been slowly developed."* Romanes, whilst admitting that the greatest difficulty is to account for the drooping of the wing, thinks that the instinct of the mother must have been assisted by intelligence, *i.e.* she might have observed "that on retreating without taking wing she was followed up,"† and acted afterwards with

* See 'Mental Evolution in Animals,' p. 316. † *Ib.*, p. 317.

intentional purpose. Naturally such birds would raise a greater number of offspring, who would inherit the tendency to perform the same device when they become mothers. Thus an original action "would slowly become organised into an instinct."

It seems to me that these practices of protection may have been otherwise developed. In the first place, the wings of a bird are ever concerned with the warmth and protection of its young, and their movements are therefore closely related to all the emotions of parent-hood. When a bird is flushed from her nest, or away from her young, she is under the influence of two powerful conflicting impulses, viz. anxiety for her progeny and self-protection. Darwin states, as a principle of serviceable associated habits:* "Certain complex actions are of direct or indirect service under certain states of the mind, in order to relieve or gratify certain sensations, desires, etc., and whenever the same state of mind is induced, however feebly, there is a tendency through the force of habit and association for the same movements to be performed, though they may not be then of the least use." Thus, movements which owe their origin to, and are frequently performed by an individual under the influence of an emotion, become repeated when the emotion is roused, even though they may be objectless. A man who is angry with another a thousand miles away will close his hand and shake his fist, and it is scarcely too much to expect that a bird just driven away from her offspring should droop her wing towards the position it usually occupies when protecting them. Such action naturally disturbs her flight, and she falls as if wounded, when as her pursuer gains on her the conflicting desire of self-protection re-asserts itself, and she rises, when again the maternal instinct prevails, and the drooping wing follows. These alternations are repeated until she observes her nest, or the place where she left her young, free from danger, when she returns there. It may be asked, How is it, then, that this feigning of injury does not occur with all birds, or at least with all the individuals of the species in which this device is observed, for there are exceptions even among partridges, peewits, and ducks? The answer appears to be that those birds in which the practice more frequently obtains build their nests on the ground, which is therefore more exposed to accidental intruders, so that the wings would be more constantly used for the purpose of passive and active protection, both as regards the eggs, and also the young when hatched. The "feigning injury" would be encouraged by stiffness if the bird had not flown for some time, but it would not occur if the desire of self-protection were considerably stronger than that of the protection of the young. That there are variations in the degree of parental instincts not only in species, but also in individuals of the same species, is a fact of which there is abundant evidence.

Mr. A. F. Buxton informs me that he has seen a water-wagtail "feigning injury" in the happiest manner, and it would therefore

* 'Expressions of the Emotions,' p. 28.

appear that ground-nests* have not so much to do with the development of the device as I have made out. These birds are, however, exceedingly solicitous as to the safety of their young, "and will almost suffer themselves to be taken off the nest sooner than forsake them."† Although in this case the nest was not on the ground, the birds build there frequently, and there is no reason why these actions should not have originated in the way I have pointed out, exclusive of the position of the nests, or have become settled as a habit in the species, previous to their selecting places of the most opposite kinds in which to build them.

The "feigning of injury" is, however, not confined to the wings, but extends to the legs. My own observations have not gone so far as to permit me to state that the bird runs away with a movement of the wings; but I should be disposed to think that the cause of falling or "limping" is due to the balance of the body being disturbed by the awkward position of one or both wings, or to a stiffness which followed a cramped position.

It appears to me that it is better to attribute the development of these special adjustments to emotions and conditions which we know to prevail, so long as they account for the phenomena, rather than to fall back on a considerable degree of intelligence to bridge over the difficulty.

The possible Origin of some Instinctive Actions.

Many actions of animals may be traced to the observation of an accidental result. Morris records ‡ that an erin or sea-eagle, finding that the tub of water placed in his cage was frozen, deliberately mounted to the uppermost perch, and "then suddenly collecting his strength he rushed down with irresistible force, and striking the ice with his powerful claws dashed it to atoms," when he "quietly allayed his thirst." Now, these birds live in a rarefied atmosphere, and we may be sure that pools to which in the wild state they were accustomed to resort were occasionally frozen when they wanted to drink. Let us suppose the ice to have been too thin to bear a bird's weight, and that as the water appeared through the broken surface he observed the substance which had hidden the water from his view. What would be more natural than that on another occasion, angry at the obstacle between him and the object sought, he flew at it in the same way as he would at ravens or crows which had taken possession of some carrion. Romanes § mentions the case of a bear in the Zoological Gardens, which, unable to reach a bun which had fallen into the water, stood on the edge of the pond, and commenced "*stirring* the water with his paw, so that it established a sort of rotatory current, which eventually brought the bun to him." When one leg grew tired it used the other, but in the same direction. Now the movement of fore-legs

* J. E. Littleboy mentions the "feigning of injury" in the turtle dove. —'Trans. Watford Nat. Hist. Soc.,' Vol. II, p. 146.

† Morris's 'British Birds,' vol. iii, p. 112. ‡ *Ib.*, vol. i, p. 10.

§ 'Animal Intelligence,' p. 351.

is a common means of expression, and especially of impatience, with dogs, horses, bears, sheep, and most quadrupeds, and one can well conceive how an intelligent animal, having originally pawed at a floating substance, observed that it came within its reach, and adopted the practice in future.

These actions on the part of the eagle or the bear which originally performed them might be so often repeated that they might become instinctive in posterity, some of which might fail to inherit them. Thus the whole species would not be similarly gifted. There is no reason why habits of the lower animals should not skip some of their descendants any more than in the case of mankind; and again we see the caution required in ascribing to intelligence actions which are not common to a species, and which at first sight may appear to be due to individual adaptation. It may, however, be said that in suggesting the above lines of development I am carrying the analogy between mankind and the lower animals too far; but it may well be remarked that if we lay claim to interpret their actions, they likewise show that they understand ours, and even those from which they obtain no advantage. I have a Persian cat, "Rough," which is a great pet in the nursery. She is much attached to my youngest nephew. When in trouble he sometimes rolls on the ground crying, and "Rough" will go to him and lick his *hair*. It is difficult to explain this in any other way than that she does so out of sympathy, and is as fully alive that he is not at ease as if he were her kitten; while the place which she licks would appear to be selected as having the nearest resemblance to the fur of her progeny.

Instincts which are injurious to the Individual.

I have as yet only referred to actions, as advantageous or pleasurable to the individual performing them, but there are others detrimental not only to the individual but also to the species, and which are sometimes called "instinctive." In all probability these injurious actions are due to the mis-direction of some habit which under most circumstances is beneficial, and they show that a species requires time to be adapted to new conditions. If for instance Australia were to become more fully populated, the male bower-bird would either have to cease building an ornamental bower to attract the female, or the species would become extinct.

The "cock up" of the male pheasant on going to roost may attract the attention of the poacher, as Darwin suggests in the "Posthumous Essay on Instinct," appended to 'Mental Evolution in Animals.' Yet the habit is beneficial to the species, for this call of the cock-pheasant draws some of the hens to him, and should he be aware of the presence of a fox, he will give the note of alarm. And again the cackle of a fowl leads to the seizure of the egg which has just been laid, but in all probability it attracts the polygamous male, and the fertilisation of each egg is thereby the more secured.

Moths and other insects frequently fly through flame. Now, as Romanes remarks, "flame in nature is an exceedingly rare pheno-

menon." The occurrence of an unprotected flame even in our country cannot have been so frequent as to lead us to expect that the habit of its avoidance could already have been developed. We can however recognise in the case of insects the material on which natural selection could act, or may be now acting. We know that all the species of moths, and all the individuals of any particular species, are not equally attracted by flame. Some few house-flies and blue-bottles will beset a candle, especially in autumn, while others pass by unheedingly. The collector's lamp is not very successful with the Bombyces, while the white ermine moths will flock to it. Again, during the revision of this paper for the press, there has been in my room for three days a red underwing (*Calocala nupta*) which has not performed any gyrations round my reading-lamp, although at other times I have often found charred remains of individuals of this species. Lights in granaries and cellars do not reduce to an appreciable degree the number of small moths which occasionally abound in such places. Many are destroyed, but sufficient numbers are left to be an inordinate pest.

Amongst Darwin's MSS. was found the following pertinent query: *—"Why do moths and certain gnats fly into candles, and why are they not all on their way to the moon—at least when the moon is on the horizon?" Romanes suggests in answer to this question that insects fly into flame just as birds fly against lighthouses, "out of mere curiosity or a desire to examine a new and striking object,"† and that "as the moon is a familiar object, the insects regard it as a matter of course, and so have no desire to examine it."‡ This view may be correct, but any explanation of these occurrences must be hypothetical. There is no evidence that curiosity is manifested by any individual not included in the Vertebrata, or at any rate by the Lepidoptera and Nemocera. Further, the action of a moth repeatedly knocking its head violently against the glass shade of a gas lamp, or of a bird in striking a lighthouse, is totally different from that of the tentative caution which characterises inquiry throughout the animal kingdom. Curiosity might, it is true, lead the moth to the lamp, but its rapid and violent gyrations must be due to some other cause. It should be borne in mind during the following explanations as to these flame-seeking habits that few of the individuals which have had any experience of flame live to apply it, and that the vast majority of animals can only interpret its appearance by a resemblance to something which is related to their habits. In the case of birds flying against lighthouses, I would suggest that in the history of their own race and within their own experience, they must have been in a dark recess, such as a well-shaded nook in a forest, or a hole in a rock or tree. Now the light of the sun as it strikes upon the egress of such places, when viewed from within, has even to ourselves a very close resemblance to a flame, and it is through such brilliant openings that birds have been accustomed to

* 'Mental Evolution in Animals,' p. 279. † *Ib.*, p. 279. ‡ *Ib.*, p. 280.

pass into the light of day. It is quite probable that some of them regard the light of a lighthouse as an exit from darkness through which they attempt to fly. B. T. Lowne, who has kept small birds, tells me that if at all wild when let loose in a room, they will either dash against the window or, on a dull day, fly straight into a bright fire. They appear to me to consider light as a road to freedom.

With the view of seeing how insects with habits not exclusively diurnal would regard a flame, I made the following experiment. I caught a few humming-bird moths, and released them in a room at night in which a lamp was burning. They all flew towards the light, and dashed repeatedly against the glass. Now these moths fly in the brightest sunshine, and in the two twilights. I found the same experiment lead to the same result in the cases of Gamma moths and daddy-long-legs, which are active by day as well as by night. The large white butterfly will fly towards the lamp if flushed during its usual night's torpor. All these insects appear to me to have committed the same error as birds when striking a lighthouse or rushing into a fire.

This hypothesis obviously cannot extend to similar actions of Lepidoptera of nocturnal habits, and I am disposed to think that these insects fly towards a flame mistaking it for a flower. The objection that a flower visited by moths has scent, and that a flame has not, is removed by the fact that bees, which are guided by both the senses of smell and sight, will visit artificial flowers. They will also walk over a flower from which the corolla is removed in such a way that the nectar remains. This would account for the attraction of a moth to flame, but its persistent attempts to enter the flame appear to be largely due to the following physiological cause. The refulgence observable in the eyes of some of the nocturnal Lepidoptera fades away quickly on exposure to brilliant light, and reappears only after a considerable time has been passed in comparative darkness. Lowne * states that this refulgence is due to a luminous reflex from the contents of the rhabdia or rods of the eyes, and that its disappearance is owing to the contraction of a ring of pigment-cells on the outer end of each rhabdon or rod. Now, if the rays of light are prevented from reaching the reflecting contents of the rhabdia, they cannot pass to the retina. The moth under these conditions is either blind, or can only receive a visual impression similar to the undefined glimmer which we ourselves perceive when we turn with closed eyelids to a lamp. If the flame be such that the moth receives no luminous sensation, it is as likely to fly into the flame or bob against the ceiling as to go in any other direction. If on the other hand the flame be brilliant, and the luminous sensation received by the moth from the direct rays approximate to that of the degree of light in which it is usually active, the moth would continually seek the flame.

I have still to refer to the question why animals which fly into flame do not fly towards the moon. Were they to do so, and the

* "On the compound vision and the morphology of the eye in Insects.'—'Trans. Linn. Soc.,' 2nd ser., Zool., vol. ii, p. 389.

moon were high in the heavens, they would be stopped in their upward flight by the rarefied atmosphere. If the moon were on the horizon, animals would find out that they were apparently getting no nearer to it, and their attention would in the end be diverted to another object, such as a flower from which they could obtain food. Their action would be similar to that frequently observed in street-boys, who, seeing a glare of a distant fire, think it quite close, and run some distance, when, finding that it seems as far off as ever, they stop at a sweet-stall.

But we do not know whether birds or moths fly towards the moon, or not. If they did, the habit might be useful as a means of distribution. Newman observes: "It is well known that on *moonlight* nights, moths forsake sugar, ivy, flowers, etc., and wholly disappear. The same is true of 'light.' When the moon comes out it is a signal for all properly-disposed moths to go to bed."* This statement is, however, opposed to the experiences of many collectors, and ought to be limited to certain species. It is quite possible that the light of the moon is sufficient to render some moths blind, and as inactive as in day-light. I am sorry to be unable to report any experiments as to the disappearance of the luminous reflex from the eyes of moths when exposed to moonlight, but I hope to refer again to the subject on another occasion.

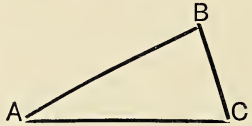
I have often been told that the flame-seeking habits of animals are due to the attraction which light exercises upon all life, but this statement is far too broad. Plants and animals require different degrees of light according to their kind and habit, and suffer as much from a superabundance as from an insufficiency. The lamp which draws a family round a table will, if it shine on a lawn, cause the eyeless worms to withdraw into their holes, and there is a limit to the brilliancy which gives pleasure to man. Darkness is concealment and safety for most humble creatures, but light is to them a source of danger, and the primary use of vision may have been the avoidance of enemies.

In concluding my remarks on the actions of animals which are injurious to themselves, it may be well to refer to the erroneous statement that a bee loses its sting whenever it stings, and dies. The fact is that death only ensues when the substance penetrated is so resisting that the muscles of the bee are not strong enough to withdraw the sting. In such cases the bee escapes, but is so injured that it dies. It is, however, strange that queen-bees should require so much provocation to induce them to sting, if indeed we except that of the presence of their own sex. They may be held in the mouth with impunity if uninjured. Young bees just out of the pupa show the same forbearance, but this may be due to partial muscular development. I am inclined to think that the cause of the queen-bee's apparent good nature is that, accustomed to a most quiet life in the hive, she is soon frightened, and like the neuter bees does not sting when thus affected.

* 'Insect-Hunter's Companion,' p. 107. The word "light" here refers to artificial light used by collectors to attract moths.

Sense of Direction.

There are many authenticated accounts of animals returning home after their removal, by a circuitous route or even by water, to a great distance. I know of a puppy which was taken from Bury in Lancashire, to Liverpool, and thence conveyed by steamer to Dumfries. There it was fastened to a carrier's cart, in order to be taken to its destination. The dog, however, slipped its collar, and returned, after an absence of two months, to Bury—a distance of about 130 miles. Romanes states that he could fill pages with letters received from all parts of the world as to similar performances by "dogs, cats, horses, asses, cows, sheep, goats, and pigs." * The same author remarks that "it is certain that in many cases, if not as a general rule, the animals on their return journey do not traverse the exact route which they had taken in the outgoing journey, but take the 'bee-line'; so that, for instance, if the outgoing journey has been made over two sides of a triangle, the return journey will be made most probably over the third side." † This power of "homing" is frequently termed "a sense of direction." Prairie-hunters and wild races display this faculty to a considerable degree when they return by a straight line to their camp after chasing the bison, etc.; and some hunters and guides attribute this accomplishment to having "unconsciously kept" all the "turns" in their mind.‡ Romanes, writing on this subject, states: "There are only two hypotheses open to us whereby to meet the facts. First, it has been thought possible that animals may be endowed with a special sense enabling them to perceive the magnetic currents of the earth, and so to guide themselves as by a compass. There is no inherent impossibility attaching to this hypothesis, but as it is wholly destitute of evidence, we may disregard it. The only other hypothesis is that animals are able to keep an unconscious register of the turns and curves taken in the outgoing journey, and so to retain a general impression of their bearings." §



Now let us suppose that a hunter on leaving his home A, takes a straight course to a spot B, where he turns (say at a right angle) and proceeds then in a straight line to a spot C. He will have described two sides of a triangle A B C, but the knowledge of the exact size of the angle A B C would not enable him to take

* 'Mental Evolution,' p. 289. † *Ib.*, p. 290.

‡ 'Brain as an Organ of the Mind,' p. 215. Quoted in this work from a letter dated from Kansas.

§ 'Mental Evolution,' p. 291.

the direct route home along the basal line CA, unless he also knew the distances he had travelled between A and B, and between B and C. A hunter might form an approximate estimate of these distances from the pace he had been going, or by the occasional comparison of landmarks. But if an animal in a closed box be conveyed by coach or railway along a similar route, it could have no idea of the rapidity of its journey, and therefore none of the distance it had travelled. The registration of such turn or angle, even if conceived to be possible, could be of but little service to it in discovering the bee-line home. This hypothetical case sufficiently represents the conditions under which animals are frequently said to have been removed to a considerable distance from home, and to have, notwithstanding, found their way back. I am, however, disposed to consider the return of an animal under these circumstances as an accidental result of the animal's undirected wanderings, or of some such interference as that of a thief stealing it, and conveying it by a coincidence to some spot which it can recognise as being near its old quarters. Animals are frequently missing from a new home, and we only hear of those who return to their old one. It is of course easy to deny the completeness of a perplexing statement, and to ask for further evidence, which we know can only be forthcoming after carefully-conducted experiments. But there is no reason why animals, as well as the prairie-hunters, should not have a general idea of the direction of their home, *when moving of their own accord*. They have then to deal with no factor outside their ordinary experience, or that of their ancestors, such as a blindfold journey in a conveyance gives rise to, without any means of estimating the distance travelled.

But the unconscious registration of turns and curves by animals, even in their own wanderings, scarcely seems to me sufficiently to account for "the sense of direction" which they appear to possess. I have already shown that the suggestion implies much more than is expressed, for the registration to be serviceable must include the exact distance between each turn, and the exact length and curvature of each curve. This will at once be seen if a route be described upon paper. Such an unconscious process must be exceedingly complex, and I will now suggest a more simple one which equally accounts for the phenomenon.

I have often lost myself in the woods about Hoddesdon. It occurred to me one day as I was about entering Boxwood, to try to constantly bear in mind the direction of the spot at which I left the beaten track. I found this at first very difficult, but the occasional practice soon grew into a habit, and I now frequently detect myself noting semi-consciously the relation between a given place and my ever-changing position. I still often make mistakes in taking a "bee-line," but my error is rarely so great as to put me to much inconvenience. I cannot, however, remember the "turns" I have taken, and cannot retrace my steps. It has occurred to me that the "sense of direction" in animals has been

similarly developed. Let us picture to ourselves an animal leaving some place of protection which we will call its home, and fearful of its enemies. After proceeding a very short distance it glances wistfully homewards, and as it cautiously moves onwards, it is ever turning towards the shortest line of retreat, apparently fixing only the direction of its home point, and allowing all intermediate impressions of position to pass out of record. It is not too much to suppose that the animal, or its descendants, would soon acquire the practice of bearing in mind the direction in which to run in case of danger, and that in the course of generations this habit would be constantly exercised for other purposes than that of safety. Now, if "the sense of direction" has been developed in this manner, animals would incline to take the "bee-line" home, as is stated to be generally the case. If they occasionally retraced their steps, I should not consider their action as due to "a sense of direction," but to its loss, which led them to employ their powers of scent and of remembrance of landmarks observed in the outward journey. It is also manifest that my hypothesis gets rid of the difficulty of the animal estimating the distance which it has travelled, and obviates the necessity for a theory of "registration of turns and curves." The animal needs but to *recognise* perpetually at any given instant its position in relation to its home, whether it is "*turning*" or "*curving*," or taking a straight course. This it could not do if conveyed in a vehicle with no means of observing either the rate at which it was carried, or the direction in which it moved.

It is obvious that animals which travel far from home have from their nature and surroundings much better opportunity of developing the faculty of direction than mankind possess. Their wants are fewer, and they are not diverted from their more simple purposes by the variety of objects that perpetually attract and draw off the attention of human beings. Every one must be conscious how much a habit of reasoning trenches upon the province of observation; yet there are moments of mental abstraction, during which some external object is unconsciously chronicled, and is often afterwards recalled and applied. The semi-conscious recognition of the direction of a locality, which, as already stated, I detected in myself, is but a step to its unconscious recognition such as displayed by the prairie-hunters. Whether or no animals exercise unconsciously this faculty, is a question that does not affect my hypothesis.

It is to be regretted that the experiments made on animals as to their "sense of direction" have been so few, and that they have not increased our knowledge of that faculty. Sir John Lubbock has indeed shown that ants are greatly aided in recognising the direction in which they are going by the direction in which the light is falling.* But this alone cannot guide them home. If, for instance, an ant left its nest in the morning with the sun

* 'Journ. Linn. Soc.,' Zool., vol. xv, p. 381.

shining on its right side, the sun would be on its left side if it returned by the same route before noon.* But this would still be the case if the ant kept on walking in the same direction, and passed its destination. In all probability, however, it would not have proceeded far on its homeward journey without recognising some landmark. Sir John shows also that ants are helped by sight in finding their way, and this prevents any conclusion as regards "the sense of direction" being drawn from the experiment in which they persistently took a short cut to their nest, from a place they had reached by a circuitous route.† Fabre has shown that a percentage of bees return home after removal to a certain distance,‡ but there is no reason why they should not be guided by actual observation. It is indeed difficult to see how "the sense of direction" could be otherwise than feebly developed in animals with a sustained power of flight, for when on the wing their range of vision is comparatively unimpeded, and would seem to be sufficient for their ordinary wants. They, like men living in civilised countries, have but little necessity for the use of this faculty. Pigeons have a great attachment to their home, but their success in "homing" is almost certainly due to observation and to sight. Before they are "flown" from a great distance they have to be trained stage by stage, so that they know the intermediate country. If a pigeon be tossed at night, or in a very thick fog, it will "not fly at all,"§ and this could scarcely be the case if it knew its way.

The course taken by migratory birds is frequently supposed to be governed by an inherited "sense of direction." The general statement that old and young birds of the same species do not migrate at the same time appears to support that view, but we do not know whether the young flight is not led by some old birds who are guided by landmarks. This suggestion cannot, however, account for long oceanic passages. Birds when flying have little or no shelter, and, unlike ourselves, have no artificial clothing. It is reasonable to suppose that they are more susceptible than we are to the atmospheric influences of different aspects, and they may by such means receive an indication of their course to a locality conducive to their well-being, both as to food and temperature. Further observations may also show that the trans-oceanic flights of birds are largely influenced by the winds, which in the migratory periods of spring and autumn are more regular than at other seasons. When they have once touched land, they may wander until they reach a suitable habitat. I cannot help thinking that it is premature to discuss the perplexities of this question.

* It must not be inferred from the above that I imagine the movement of the sun towards the west would necessarily invalidate the ant's reckoning when steering for home. I should not be at all surprised to find it ascertained that bees, wasps, ants, and birds (if not most diurnal animals), could make approximately accurate allowance for the gradual changing phenomena of light as occurring in the sun's diurnal course.

† *l.c.*, p. 383.

‡ 'Mental Evolution,' p. 293.

§ 'The Belgian Homing pigeon,' p. 18.

The annual report on the "Migration of Birds" is steadily increasing our knowledge of the facts connected with the whole subject, and we may find that many phenomena, for which explanations are now sought, are mere accidental results. It is hardly necessary to state that the return of birds to their old nests cannot be taken as evidence of their possessing a "sense of direction," for, having been there before, they may be guided by landmarks, within sight of which their migratory course may have taken them.

General Remarks.

All analysis requires as a preliminary the most careful elimination of any accidental relation of the subject under examination. In no enquiry is this more important than one dealing with psychical phenomena, which frequently from their very nature are associated with more or less glamour, or endued with it by the observer. Butterflies often visit the droppings of birds, and a spider in Sumatra and Java (*Ornithoscatoides decipiens*, Forbes) spins "a thin white web on the surface of a leaf, by means of which it secures itself on its back to the leaf, leaving its legs free to enclose and seize any insect unwittingly resting upon or crossing it." * The web with the spider has all the appearance of recently-left birds' excreta. Now it is impossible to think that the imitation is intentional, but it is the imitation which causes our admiration. It is reasonable to believe that the spider which originally made this web did so just as other spiders or caterpillars spin threads for their protection. Food was thus obtained, so that there was no cause for making another snare. The practice was transmitted to posterity, and natural selection not only increased the resemblance of the snare, but probably also modified the colour of the spider, which, in the attitude described, completes the deception. Or again, the tom-tit may attract attention as it taps with its beak at the entrance of a hive,† and seizes the angry bee which comes out. But a woodpecker will receive but a passing glance as he taps a loose piece of bark, and picks up the scared insects, which are leaving their protection.

One great source of error in estimating the intelligence of domestic animals, and more especially that of dogs, is in considering that the information we derive from their actions is always *intended* to be conveyed to us, as is undoubtedly sometimes the case. A son of a friend of mine visited a farmer just as he was starting on a poaching-expedition, and joined him out of love of adventure. The net was placed at one side of a copse, and the dog began to beat the game towards it, but he shortly returned and declined to leave his master, in spite of threats and blows. It was ultimately suggested that

* See "On the habits of *Thomisus decipiens*," by H. O. Forbes; 'Proc. Zool. Soc.,' 1883, p. 586; and also "On two new genera of Spiders," by O. P. Cambridge; 'Proc. Zool. Soc.,' 1884, p. 196.

† Some people about here call the tom-tit "Take-a-bee"—a term which is possibly as much due to the bird's note as to the above occasional practice, which unfortunately I have not seen myself.

some one might be approaching, and a few minutes afterwards the keepers passed. I have never told this story without some one exclaiming, "Oh! wise dog to tell his master!" but it is the master and not the dog who deserves credit for intelligence. The incident seems to me capable of explanation as follows. Most dogs like the pursuit of game, and some of them are confirmed poachers. In all probability the one in question had often, while sporting by himself, come across a keeper, who had inflicted slight shot-wounds upon him, or at any rate frightened him. He would thus know what to expect when he heard any one approaching, and if alone would run away as a cat does when caught robbing a table. In the case just mentioned, the dog, instead of making good his escape, returned to his master, which is exactly what he would have done on any ordinary occasion. The above hypothesis is to a certain extent confirmed by the observation of others and myself in this respect, viz. that some dog-poachers when out for a walk with their masters will enter a wood, and invariably return to heel very shortly after the report of even a distant gun. Further enquiry leads me to think that some poachers owe their immunity from capture to close observation of the behaviour of their dogs.

Some years since I entered my room with a friend, and saw a weevil walking across the mantelpiece, when I called out "Halt!" The insect stopped, and my friend thought it was a trained pet, but it would have done the same thing had I said "Go on!", for the habit of this group is to remain still on the occurrence of a sudden noise. Field-naturalists frequently offer explanations for phenomena which puzzle philosophers, and can equally well enter into the spirit of Montaigne, who when playing with a cat suddenly thought that the cat might be playing with him; in other words, she might be quite aware that her business and sport were to catch mice, and might be also conscious of her condescension in playing with a man, whose actions had no relation to her primary objects in life, and whom she therefore regarded as inferior to herself in every way except in physical force. The cat might be excused for thus estimating the intelligence of man by a cat-standard, inasmuch as man is apt to consider the habits of animals in their relation to *him*, and not to themselves. But although the sphere for the exercise of the energies of man is more extended than that of other animals, he is no exception to the physiological bond which unites the whole animal kingdom, nor to the psychical bond which extends wherever there is consciousness. When we are well we walk erect—muscular energy is active. The dog cocks his tail from the same cause; while the opposite condition involves the drooping tail, as well as the bent human gait. Landseer could not draw with half-closed eyes and unraised ears the small dog in "Dignity and Impudence," and the actor who plays with firmly-set muscles the discomfited Shylock as he says, "I am not well," commits a physiological error. The dog that runs away tucks his tail tightly between his legs to keep it as far from the pursuer as possible, and a somewhat similar prudence has become habitual

with some individuals when frightened. Many ladies perform an analogous action when they clasp their dress close on hearing that there is a cockroach in the room. A stick at the entrance to a bee-hive will cause a bee hurrying home to trip, just as it would if placed in a merchant's hall on his return from the City. We even see in the modulations of the various sounds of animals—betokening as they do different emotions, and understood as they are by each other—a primitive language, which under emotional excitement so resembles that of human beings in pitch and note that we are enabled to realise the related psychical conditions.

The actions of animals, whether regarded as reflex, instinctive, or intelligent, are no recondite phenomena incapable of investigation, and we may be sure that new biological and physiological facts, when regarded by the light of the laws of inheritance and natural selection, will elucidate the development of many habits on which at present we can only theorise. Nature has no paradoxes. They arise from man's ignorance of facts, or from his defective power of generalisation.

XVI.

THE ORIGIN AND CONSTITUTION OF CHALK AND FLINT, WITH SPECIAL REFERENCE TO THEIR FORAMINIFERA AND OTHER MINUTE ORGANISMS.

By Professor T. Rupert Jones, F.R.S., F.G.S.

A Lecture delivered at Watford, 20th January, 1885.

Contents.—Introduction. Range of the Chalk. Order of Succession of the Cretaceous Formations. Origin and extent of the Chalk as a marine deposit. Extraneous Materials in the Chalk. Post-Cretaceous changes. Organic Remains found in the Chalk. Vertebrata. Invertebrata : — Molluscs, Annulosa, Echinoderms. Polyzoa and Corals. Sponges. Foraminifera, etc. Coccoliths, etc. Flint. Conclusion.

Introduction.—The pleasing task I have undertaken to-night is to talk about the Chalk, its origin and its constitution. It is a very large subject, and divides itself into two or three branches, each of which might be made a lecture of itself. On one branch, namely, the geographical range of the Chalk, you have had a very interesting lecture by my friend Mr. J. Logan Lobley a few years ago.* Another lecture, by Professor Morris, gave much valuable information about the Tertiary Beds overlying the Chalk of the South-east of England.†

Range of the Chalk.—Of course I shall not trench upon the ground traversed in the two Lectures to which I have alluded; and you must be so kind as to remember the chief geological facts and inferences as to the range of the Chalk,—namely, that it belongs to a very extensive set of strata reaching northward and eastward in England from the coast of Dorsetshire, with its outcrop at the surface across Wiltshire, Berkshire, Bucks, and Herts, to Cambridge and away to Yorkshire; and showing itself on the south-east in the extensive but narrow tracts of the Hampshire hills and the North and South Downs. Of course you are aware that this does not show the whole of the Chalk. Looking at one of the diagrams on the wall, those of you who have not thought much of the matter will understand what we mean when we say that the Chalk crops out, is exposed, or forms the surface here and there; for, in this section,‡ reaching from Hampshire into the London area, you will see that there is an arching in the lines representing strata of Chalk and overlying Tertiaries, and the centre of the arch comes up to the surface at Salisbury Plain and thereabout, exposing the Chalk; but away to the south and to the north-east the same set of lines is covered up with those of other strata, such as the Thanet Sands, Woolwich-and-Reading Beds, and London Clay, which are found also in this neighbourhood or not very far off. Looking abroad, geologists find that the Chalk, that is, the upper portion of the Cretaceous series of strata, occurs not only in Great

* 'Trans. Watford Nat. Hist. Soc.,' Vol. I, Part 1, p. 1.

† *Ibid.*, Vol. I, Part 4, p. 89.

‡ Copied from Prof. Prestwich's paper, 'Quart. Journ. Geol. Soc.,' vol. x, pl. i, fig. 1.

Britain, but in Denmark, North and South Russia, Belgium, and France, with its equivalents in Rhenish Prussia, Westphalia, and elsewhere in Europe, and in North Africa and Western Asia, for an extent of nearly 3000 miles W. and E., by 1000 miles N. and S.

Order of Succession of the Cretaceous Formations.—On the wall there is another section, to show a local outcrop of not only the Chalk, but of other beds which belong to the same geological system, and which preceded it in its formation. Thus the "Chalk-marl," the "Upper Greensand," the "Gault," and the "Lower Greensand" (the Uppermost Neocomian) are seen to succeed one another in the high Chalk escarpment passing through Berks, Bucks, and Herts. In some parts of the South-east of England the fresh-water Wealden Beds are the lowest of the *Neocomian* beds, and the so-called "Lower Greensand," which is a marine and upper member of the same great formation (more developed on the Continent), succeeds with some clay beds, but with much thicker irony sands and sandstones. These are the Woburn Sands of Bedfordshire, etc., forming a wide sandy country below the Chalk escarpment, and divided from it by the hollow and often wet clay ground of the Gault. This last is about 100 feet thick; and northwards it passes into the "Red Chalk" of Hunstanton. It is succeeded in Berks by 20 or 30 feet of "Upper Greensand," a soft calcareous sandstone with green (glauconitic) grains, which becomes thinner to the N.E., and gives place to the "Chalk-marl" or "Grey Chalk." This is a tough argillaceous chalk, at some places greenish and sandy; and near Cambridge its base consists of a thin bed of rolled nodules and broken fossils (derived from the Gault), sufficiently phosphatic to be worked for the manufacture of manures. Elsewhere, as in Bucks, for instance, the Chalk-marl is 80 feet thick, with some stony beds in it; on it there is the "Totternhoe Stone," two layers of hard, brownish-grey, sandy chalk, used for building, and about 6 feet thick; then White Chalk (without flints), or "Lower Chalk," nearly 500 feet thick; next comes another well-marked, thin, hard stratum, first recognised and called "Chalk-rock" by Mr. W. Whitaker.* It is only about 4 feet thick, but has been traced for long distances, on account of its being a yellowish or cream-coloured chalk dividing up into green-coated nodular masses. It is rich in fossils, such as belong generally to the Lower Chalk; some small *Baculites* and *Scaphites* are peculiar to this bed, and these I have met with in Kent in probably the same stratum. White Chalk (with flints), or "Upper Chalk," forms the upper portion of this Cretaceous Series, with a thickness of 300 feet. Thus the whole is about 890 feet thick in Buckinghamshire; but it has a greater thickness in the Isle of Wight (1336 feet) and elsewhere.†

* 'Quart. Journ. Geol. Soc.,' vol. xvii, p. 167; and 'Mem. Geol. Surv., Explan. Sheet 7,' 1864, p. 5.

† See Horace Woodward's 'Geology of England and Wales,' 1876, p. 250, etc.; and Dowker, 'Geol. Mag.,' vol. vii, p. 470. The student should also refer to Jukes-Browne on the Divisions of the Chalk, 'Geol. Mag.' dec. 2, vol. vii, p. 248; and to C. Barrois' papers on the Chalk, especially his 'Recherches sur le terrain crétacé supérieur de l'Angleterre et de l'Irlande,' 1876.

Origin and extent of the Chalk as a marine deposit.—The origin of the Chalk, with regard to its deposition, was touched upon in Mr. Lobley's lecture, but I think we may enlarge upon it a little. Here is a rough map (after M. Elie de Beaumont) of what was the sea-area in which the Chalk was deposited; the *blue* representing the sea where the chalk beds were being formed, the *yellow* the lands, and the *light tints* where one or the other are not known for certain. If you look at the geographical conditions, you will see that cities and towns which now exist look very oddly placed with regard to land and sea in that map. The sites of London and Southampton are in the midst of the old sea, and so also are those of Cambridge, Hamburg, and Copenhagen, to the N.E., and of Paris and Tours to the S. A great stretch of main-land and islands occupies the middle of what is now Europe, but to the S. and the E. the sea is open; for it stretched away into the African area by Nubia, and over the East-European into the Western and Central Asiatic regions. In the far West the Cretaceous Ocean covered various areas where the North-American Continent now stands. My map, however, indicates only one stage in the extent of this great sea; it had been less; and as every sea-coast has its true littoral deposits, and as with the deepening of the sea (that is, the sinking of the sea-bed and neighbouring land) these shallow-water sands and shingles (if not washed away by the waves) are covered up by the advancing mud, shell-banks, or ooze of deeper water, there must be strata of both kinds laid down successively near the coast-lines, and yet the members of each set are continuous over more or less of the sinking tract. This is shown by my diagram here of intercalating beds of rough and fine materials at the foot of the cliffs of a sinking shore; each layer of pebbles and sand being continuous, and therefore contemporaneous, with sands and shell-beds of the deep water of the same period.

Many of you, doubtless, have found that in studying geology you must forget most of the principal features of existing geography. The present conditions, shapes, and heights of land have little to do with the extent of land in the times of which we have been speaking.

The geography of the present day has come out from an older geographical condition. The geographical arrangement of sea and land was not persistent,—it had been something else, and it became something else in the course of a few ages. The map marks only at one stage the arrangement in that Cretaceous period. Nevertheless, as already intimated, the different kinds of strata, such as would be formed in deep water and in shallow water, respectively, guide the geologist in mapping out where coasts and shoals and abyssal seas formerly existed. The White Chalk itself is such a friable limestone, consisting of oceanic Foraminifera and other organisms, as would be deposited in a deep (but not abyssal) ocean; indeed the Globigerina-ooze of the Atlantic and Pacific is an analogue; and, according to our well-established knowledge, there must have been shallower and shallower waters with their muds,

sands, and shingle at the same time; just as in that diagram-section of the North Atlantic we see a broad marginal plateau off the Irish coast, at first littoral and very shallow for about 60 miles, then for nearly 200 miles with a varying depth down to 500 fathoms; then a rather steep slope into the abyssal depths, which, varying from 1700 to 2400 fathoms, continue for about 1900 miles, when a gentle slope rises up for about 300 miles to the plateau, 180 miles wide, with shallow water off Newfoundland. The marine life found at these several depths, and in many seas, both near land and in mid-ocean, is now fairly well known; and geologists can compare oozes, silts, and sands, with marls, muds, and other "rocks," and the fossils from different strata with the known creatures brought up by dredge, trawl, or sounding-line in various oceanic areas. The geological application of our knowledge of deep-sea forms is treated in a masterly manner by Professor Prestwich in his "Anniversary Address" to the Geological Society in 1871.*

The late Mr. R. A. C. Godwin-Austen was among the first to work out the geography and hydrography of the Cretaceous Period: his views as to the distribution of land and water at that distant time are given in a paper read before the Geological Society in 1855.† A gulf or relatively small sea, where now Southern Europe is, remained after the post-Jurassic changes, and this increased northward, with Purbeck-Wealden estuaries and lakes, until it was the Neocomian shallow sea; and the area still sank and the sea widened, overlapping and burying the remnants of its old shingle-banks and sand-shoals in new deposits time after time, until the thick Gault and its sandy equivalents and succeeding beds were formed, oscillations of the land limiting the successive formations, as the relative level of land and sea was interfered with. Then a steady and long-continued subsidence of the region went on until neither tide nor storm could shift the sand and shingle of the shores into mid-ocean, where only wind-borne volcanic dust, and fine mud and the finest sand could be carried by ocean-currents to mingle with the calcareous microzoa which mainly constituted the deep-sea deposit there. Thus was the Chalk-marl formed, with occasional chemical precipitations, perhaps, and certainly local developments of marine life, either as abundant Sponges or limited groups of Molluscs, to originate thin beds of different consistence and aspect (Totternhoe Stone and Chalk-rock). After a time—a long time—even the argillaceous material ceased to be brought to the inner expanse of the widening ocean; and Foraminifera, sponge-spicules, and coccoliths supplied the chief material of the soft ooze of the sea-bed, on which the Echinoderms and Molluscs of the period existed.

At this phase of its existence the Cretaceous Ocean, or great Chalk Sea, had an east-and-west extension, with islands and archipelagos here and there, whilst there was probably much land along its northern border, and a great east-and-west Continent in

* 'Quart. Journ. Geol. Soc.,' vol. xxvii. † *Ibid.* vol. xii, p. 68, etc.

the Southern Hemisphere, if Mr. S. V. Wood's view of the circumstances be correct.* Professor Prestwich ("Geological Address," 1871) considers that for a long period the northern border of this ocean was continuous, but that at the end of the period an opening took place which allowed an Arctic current to go southward; and Mr. S. V. Wood considered cold currents to have come from the south.† These so much cooled the sea that the molluscous and other animals were much affected by the change, and many, such as the Ammonites and their allies, ceased to exist therein.

Extraneous Materials in the Chalk.—Even before the Arctic opening existed, the northern coasts, probably a little to the S. of 60° north latitude (Godwin-Austen), had winters at least sufficiently cold to form coast-ice, which floated off southwards with rock-fragments and pebbles from the shore, to be subsequently dropt from the melting ice in the open sea. This would account for the occurrence of the "Purley Boulder," a large rounded block of granite in the Chalk at Purley, near Croydon.‡ This boulder (felspar and quartz with interstices, perhaps Scandinavian) was accompanied by a mass of rotten, broken, and rounded augitic greenstone and loose quartz sand, all of which must have been held together at first, and then precipitated together, in a way which ice alone will account for. Other materials foreign to the Chalk are also found in it§—namely—volcanic scoriæ, clay-slate (in flint), green schist, quartz (varieties, some pebbles), quartzite (13lb. 14oz. in weight at Lewes), sandstone and quartz-rock (in pieces of 2lb. or 3lb., and 14lb., scattered over one level in Houghton chalk-pit, Sussex), micaceous sandstone, spicular chert, greenstone, and soft sandstone; also basalt and syenite in Ireland. These are all waterworn to a greater or less degree, and were evidently removed from the upper marginal zone (shingle-line) to the greater depths. Some were first shifted to the submarginal zone, where such pebbles and fragments become coated with small parasitic shells, natural to that depth and condition (Godwin-Austen), and then carried further down the slopes by currents or otherwise. To this list also belong numerous fossils found frequently in the Chalk, such as fragments of *Sphærulites* and other shells; the little corals (*Parasmilia*), which have always broken stems, having been forcibly removed from the submarginal zone; the *Polyzoa*, *Serpulæ*, small *Ostreæ*, etc., so frequent on the deserted tests of Echinoderms, and such dead shells themselves, though others quite perfect were also imbedded where they lived.

Thus many fossils common in the Chalk, as well as extraneous stones, have been drifted from shallower waters nearer the shores. Floating trees and seaweed with attached molluscs and other organisms may have carried some things seaward; fishes and large

* 'Phil. Mag.' 1862, and 'Quart. Journ. Geol. Soc.' vol. xvi, p. 328.
† 'Quart. Journ. Geol. Soc.' vol. xvi, p. 329.
‡ *Ibid.* vol. xiv, p. 252.
§ *Ibid.* vol. xiv, p. 254, etc.; and Dixon's 'Geology of Sussex,' 2nd ed., p. 129.

univalves crammed with shells from the shallows may have been buried in deep muds;* and sharks, like crocodiles, are said to swallow pebbles, and these evacuated or disgorged, or left on the decomposition of the carcase, would fall in strange regions; but ice alone could carry the heterogeneous mass of blocks and sand found at Purley, or the block of coal found in the Chalk of Kent.†

Besides the drifted shallow-water organisms found in the Chalk, the many other fossilised shells, Echinoderms, etc., are, in the late Dr. J. Gwyn Jeffreys' opinion (and as an experienced Conchologist he could speak with much authority), really such as must have lived in comparatively shallow water;‡ that is, the abyssal fauna of the Atlantic is by no means identical with the Chalk fauna, although some *genera* of Echinoderms and Sponges dredged up by the "Challenger" Expedition appear to be identical in the two, and several, having biological alliance, are interesting analogues.

Post-Cretaceous Changes.—The further history of the Cretaceous Ocean is complicated. Some parts of it, if not all, were silted up and became shallow seas, lagoons, and dry land in time; and the gradation of one or another set of strata above the Chalk proper into Tertiary beds, and their long-continued Lower, Middle, and Upper successions, are traceable in one region or another. In Western Europe, however, the Chalk became the floor of a shallow sea, with shelly beds of the Thanet Sands at one place, and at another seaweeds rooting themselves in its flat-planed surface (at Reading, Newbury, etc.), and oyster-beds preceding the local fresh-water conditions. Previous to this, however, and again and again afterwards, the Chalk and its associated strata were strained and bent and broken, lifted in one place and let down in another, by the lateral crush and oscillatory movements of the Earth's crust, leaving heights to be denuded and hollows to be filled up, until the geographical conditions became what we see them to be now, and the geological sections such as I have described (page 144). To what extent the Atlantic basin represents the Post-Cretaceous subsidences,§—how far it participated in the sinking not only of a part of the Cretaceous basin, but of the subsequent Eocene and Miocene seas, which stretched across W. and E., and have left the Mediterranean as a limited relic of their last stages,—it is difficult to say. We are not concerned at present with these considerations, except in remembering that the present "Atlantic ooze" (with its grey and red clays, and diatomaceous and radiolarian silts) is a thick and still-increasing covering of former sea-beds, and differs in many and important respects from the White Chalk to which in books it is often likened.

* 'Quart. Journ. Geol. Soc.,' vol. xvi, p. 324.

† See Godwin-Austen's interesting paper on this subject in the 'Quart. Journ. Geol. Soc.,' vol. xvi, p. 326.

‡ Dixon's 'Geology of Sussex,' 2nd ed., p. xxiii.

§ Dr. W. B. Carpenter has treated of this subject—see his Lecture, Brit. Assoc. Meeting, Brighton, 1872.

Organic Remains found in the Chalk. Vertebrata.—More than 3000 species of aquatic animals have been recognised by palæontologists in the Chalk. Although no relics of either Mammals or Birds have been discovered in the English Chalk, yet high-class Reptiles are well represented by scattered remains of *Pterodactylus*, *Mosasaurus*, *Leiodon*, *Raphiosaurus*, *Coniasaurus*, *Dolichosaurus*, *Chelone*, *Polyptychodon*, *Plesiosaurus*, and *Ichthyosaurus*.* Of Fishes there are innumerable specimens of teeth, scales, and bones, representing three genera of Chimæroids, about fifteen genera of Plagiostomes (Sharks and Cestracionts), twelve genera at present grouped as Ganoids, and twenty-two genera of Teleostean Fishes.† None of these, however, have supplied any considerable quantity of material in the formation of the Chalk.

Invertebrata. Molluscs, Annulosa, Echinoderms.—The Cephalopodous Molluscs are in some beds numerous; as *Belemnites* (*Belemnitella*), *Nautilus*, *Ammonites*, *Scaphites*, *Turrilites*, and *Baculites*. Excepting *Nautilus*, they have no living representatives. Their remains have added no appreciable mass to the Chalk. The *Gastropoda* are relatively rare in the Chalk, but are not wanting in numbers at places. The *Conchifera*, especially the *Monomyaria*, or those related to the oyster, spondylus, pecten, scallop, and perna, are abundant, and whole beds are composed of the *Inoceramus* shell and of its constituent prisms in a loose disintegrated condition. The *Dimyaria* are not absent, though rarer. Of the *Brachiopoda* (*Molluscoida*), *Kingena*, *Magas*, *Argiope*, *Crania*, *Terebratulina*, *Terebratella*, *Terebratula*, *Waldheimia*, and *Rhynchonella*, are well known for their occasionally local abundance. Of the *Annulosa*, none of the Cirripedes and Crustaceans (some as high as the Lobster group) are abundant, except the minute bivalved *Ostracoda* (*Cythere*, etc.), and these occur in crowds among the washings of different beds of Chalk. Of Annelids, there are numerous examples of the tube-shelled *Serpulæ*.

The *Echinodermata* are abundant and varied. The Crinoids are *Marsupites*, well known in certain bands of White Chalk at Margate and near Arundel; and *Bourgueticrinus* and *Pentacrinus*, both of which help to make up some beds by their innumerable ossicles. Of the Echinoids, many species of *Cidaris*, *Diadema*, *Cyphosoma*, *Echinopsis*, *Salenia*, *Echinoconus* or *Galerites*, *Discoidea*, *Echinocorys* or *Ananchytes*, *Holaster*, *Epiaster*, and *Micraster*, are well known. The flint casts of some are so abundant in the Chalk districts that the country-people know them as fairy loaves (*Ananchytes*), fairy helmets (*Galerites*), shepherds' crowns (*Cidaris*), and fairy hearts (*Micraster*). These sea-urchins and sea-eggs have evidently added much to the sea-bed of their day. Their tests or shells are often found whole in the Chalk, with their plates and spines quite perfect; very often indeed the tests are destitute of spines, and were dead before being buried, and

* See Dixon's 'Geol. Sussex,' 2nd ed., p. 407, etc.
† *Ibid.*, pp. 387-406.

parasitic shells, polyzoans, and annelids often bear evidence also to that fact. Not unfrequently such Echinoids have been crushed before imbedment, probably by ground-feeding fishes having grabbed them as prey, and for some reason dropt them more or less injured. The Starfishes are not so numerous in the Chalk; but *Oreaster*, *Goniaster*, *Stellaster*, *Arthraster*, and *Ophiura* are good representatives of this great group of the *Echinodermata* in the Chalk sea.

It is to be remarked, in the case of *Echinoderms* and of such shells as *Ostrea* and *Inoceramus*, that although retaining their substance in the Chalk itself, the substance has often disappeared when these fossils occur in flint that has been at all exposed to the action of air and water, whether within the Chalk or outside on the ground. This is to be accounted for by the fact, that these tests, plates, spines, and ossicles of Echinoderms and the shells of the Conchifera alluded to have never been changed into flint, as is the Chalk around them (as far as the individual nodules of flint are concerned), and that when submitted to the action of water they have been dissolved away, and corresponding cavities have been left. These hollows have in some cases been subsequently more or less occupied by chalcedonic flint while still in the Chalk.

Polyzoa and Corals.—Another group of organisms, small in size but numerous, are the *Polyzoa* of Busk (*Bryozoa* of Ehrenberg), belonging to the *Molluscoida*, but at first sight often looking like corals. Many genera and species occur in the Chalk—*Diastopora*, *Clypeina*, *Idmonea*, *Desmepora*, *Petalopora*, *Pustulopora*, *Holostoma*, *Marginaria*, and others, either free or parasitic, which are worthy of further study.* Of Corals there are but few and small kinds in the Chalk of England. *Parasmilia*, *Trochosmilia*, *Caryophyllia*, and *Diblasus* are the most common.

Spŏnges.—"Remains of sponges abound in the Chalk; for mineralized sponge-tissue and the spicula of sponges are scattered throughout, and often thickly imbedded, as may be found with care in the Chalk itself, and readily seen in the flint which has replaced much of the Chalk in nodular and tabular masses." † *Ventriculites* and *Siphonia* (*Choanites*) are among the most common of the sponges in the Chalk of the South of England ‡; but *Seliscothon*, *Verruculina*, *Stichophyma*, *Scytalia*, and *Pachinion* are characteristic Sponges in the Chalk of Yorkshire. In his Memoir on "Fossil Sponge-Spicules from a hollow flint in the Upper Chalk at Horstead in Norfolk,"§ Dr. G. J. Hinde described and illustrated 160 forms of spicules; referring them to 38 species of 32 genera of Sponges. In his greater work, a "Catalogue of the Fossil Sponges in the British Museum," with its numerous beautiful plates,‖ he enumerates the known Sponges of the Upper White

* Dixon's 'Geol. Sussex,' 2nd ed., p. 314, etc.
† *Ibid.*, p. 287:
‡ *Ibid.*, Prof. Sollas' remarks, p. 287 and p. 448, etc.
§ 8vo. 1880.
‖ 4to. 1883.

Chalk and the Maestricht Chalk (which is rather higher in succession) together, at pp. 227-229, and groups them thus :—

	Genera.	Species.
1. Monactinellidæ (Monaxinellidæ)	3	6
2. Tetractinellidæ	6	10
3. Lithistidæ	30	70
4. Hexactinellidæ	29	68
5. Calcispongiæ	5	7

Of No. 1 group, the parasitic boring *Cliona* is a well-known form, on account of the flint casts of the tubes and chambers, which it has made in *Inoceramus* shells, being often seen in the places where these shells, or fragments of them, have been imbedded in flint nodules. The shell has gone, leaving its shape and the impressions of its prismatic structure in the flint, whilst the chalk-mud once filling the little pipes and cavities has been exquisitely replaced by flint. Also in Belemnites and Echinoderm-plates *Cliona* has been noted.

In No. 2 group Dr. Hinde enumerates *Ophiraphidites*, *Tethyopsis*, *Stelletta*, *Geodia?*, *Thenea*, and *Pachystrella*.

No. 3 group comprises *Doryderma*, *Phymatella*, *Callopegma*, *Trachysycon*, *Siphonia*, *Hallirhoa*, *Jerea*, *Thecosiphonia*, *Thamnospongia*, *Pholidocladia*, *Ragadinia*, *Plinthosella*, *Phymaplectia*, and others, from the Upper Chalk of South England.

No. 4 group has many Upper-Chalk genera and species, for instance, *Craticularia*, *Verrucocœlia*, *Guettardia*, *Coscinopora*, *Ventriculites*, *Cœloscyphia*, *Polybastidium*, *Cephalites*, *Placotrema*, *Plocoscyphia*, *Tremabolites*, *Etheridgea*, *Toulminia*, *Camerospongia*, *Callodictyum*, *Diplodictyon*, *Cœloptychium*, *Stauractinella*, *Hyalostelia*, etc.

No. 5 group has for its English forms in the Upper Chalk *Elasmostoma* and *Pharetrospongia*.

Foraminifera, etc.—It has been stated that one cubic inch of some Chalk contains hundreds of thousands of easily-visible small organisms, together with incalculable millions of minute granules, mostly recognisable as Coccoliths.* To show that the Chalk is rich with microzoa, I may mention that some years since an elderly friend of mine once went with his wife to see Windsor Castle, and they rested awhile in an arbour-like grotto made in the chalk of one of the terraces. Being a naturalist, he scraped off a little of the chalk; and at home, having washed and prepared the powder, he picked out from it all the Foraminifera and Ostracoda which you see so neatly mounted on these two glass slides!

If a piece of chalk be carefully examined either in slices prepared for the microscope, or as a carefully-disintegrated, washed, dried, and sifted powder, its numerous constituent particles are found to be generally some or other of the following, in different proportions in different specimens.

* See Huxley's "Lecture on Chalk," 'Macmillan's Magazine,' 1868, p. 396, etc. Very suggestive remarks on the Chalk and its history are given in Sir Charles Lyell's "Lecture on the White Chalk, with remarks on the theory of progressive development," in 'Literary Gazette,' January, 1851, No. 1824. See also Prof. C. Lapworth's "A Piece of Chalk," in 'Science for All,' vol. v.

Small *Serpulæ*, *Ostreæ*, *Brachiopoda*, etc.
Fragments of shells, especially prisms of *Inoceramus*.
Ossicles of Crinoids.
Spines, plates, and fragments of Echinoids.
Ostracoda (abundant).
Foraminifera (abundant), and Radiolaria (*Polycystina*: rare).
Skeletal fragments and spicules of Sponges.

If examined with high magnifying powers,

Coccoliths, and in some cases Rhabdoliths.
Diatomaceæ have been recorded by Ehrenberg as found in the Chalk of Gravesend, namely *Fragilaria rhabdosoma* and *Fr.* (*striolata*) *pinnata*. See 'Ann. and Mag. Nat. Hist.,' ser. 4, vol. ix, p. 301.

In the foregoing list the majority are calcareous organisms, or rather they have calcareous shells or other structures made of carbonate of lime, which they take in with their food and leave as solid material when they die. Most of the sponges, however, have siliceous skeletons or spicules; the Polycystina have a siliceous framework; and the minute diatomaceous Algæ, of course, have siliceous frustrules. Of the last, the known evidence is very scanty. Of *Polycystina*, however, Dr. Wallich has discovered *Astromma*, *Halliomma*, and *Podocyrtis*, also some of the allied *Dictyochidæ*.* Previously I had known of only one specimen (in the Rev. H. Eley's collection); but Professor Zittel had noticed some in the Chalk of Germany. There is no doubt that both Diatoms and Polycystines live freely floating in the water, and their skeletons therefore have fallen down to the bottom to become with others a portion of the sea-bed. Of the spicules of Sponges some notice has already been taken (page 150). A list of the *Ostracoda* of the Chalk and associated strata, revised in 1870, is given in the 'Geological Magazine,'† and those found by Mr. Joseph Wright in the Antrim Chalk (some of them new species) are enumerated in the 'Proceedings of the Belfast Naturalists' Field Club.'‡

Some notes on and a list of the *Foraminifera* known from the English Chalk and Chalk-marl are published in my 'Catalogue of the Fossil Foraminifera in the British Museum.'§ Those belonging to the two formations are sufficiently distinguished; and those from the Chalk of Antrim are given in a separate list.‖ Of the Crustacean and Rhizopodal groups of these Microzoa a brief account was given by me in a lecture before this Society in November, 1882.¶ which need not be repeated here; but a few words on the Foraminifera, as to the relationship of those now living in the Atlantic, and other deep seas, with the Chalk, may be acceptable. In the masterly 'Report on the Foraminifera dredged by H.M.S. "Challenger"' [and other expeditions], by H. B. Brady, Esq., F.R.S.,** we have the results of his long-continued and enlightened

* In flint from Surrey. See 'Ann. and Mag. Nat. Hist.,' July, 1883, p. 52.
† Vol. vii, p. 74, etc.
‡ New ser., vol. i, 1875, Appendix, p. 81 and p. 92.
§ 8vo. 1882, pp. 85-88. ‖ pp. 88-90.
¶ 'Trans. Herts Nat. Hist. Soc.,' Vol. II, pp. 169-171.
** 2 vols. 4to. 1884.

researches in this group of Rhizopods, and we are enabled to compare the living and fossil forms with more exactitude than heretofore. The Foraminifera being of simple structure and lowly life, and capable of existing under a great variety of conditions, have a somewhat similar appearance throughout all faunæ in which they occur; nevertheless there is a peculiar and local *facies* in each separate and successive group, besides the presence or absence, abundance or paucity, of particular genera and species. The Foraminifera of the Chalk have their own well-marked *facies*, and there are relatively few species or notable varieties living now that lived in the Chalk-sea. Taking the North-Atlantic alone, its fauna at present comprises about 5 per cent. of the Cretaceous species of Foraminifera, and its Molluscs and Echinoderms are far from being the same as those of the Chalk. Moreover, the Foraminifera seem to be of such growth and aspect as are usually presented among Foraminifera living at far less than abyssal depths; and with this, as we have already noted (page 148), the Molluscs are said to agree.

An interesting point in the study of Foraminifera is a recognition of those which, living only at or near the surface of the ocean, have been termed "pelagic," as distinct from those which live on the sea-bed. It became of late years almost a party-question as to whether *Globigerinæ* were solely "pelagic" or not. The species known for certain to have been taken at the surface are—

Globigerina bulloides, d'Orb.*
——— *dubia*, Egger.
——— *marginata* (Reuss).*
——— *inflata*, d'Orb.
Globigerina rubra, d'Orb.
——— *sacculifera*, Brady.
——— *conglobata*, Brady.
——— *æquilateralis*, Brady.

(Eight out of sixteen species in H. B. Brady's 'Report.')

Orbulina universa, d'Orb.*
Hastigerina pelagica (d'Orb).*
Pullenia obliquiloculata, P. and J.
Sphæroidina dehiscens, P. and J.
Pulvinulina Menardii (d'Orb).*
Pulvinulina tumida, Brady.
——— *Canariensis* (d'Orb.).
——— *crassa* (d'Orb.).
——— *Micheliniana* (d'Orb.).*

(Five out of thirty-two in H. B. Brady's 'Report.')

The following are less certainly "pelagic":—

Candeina nitida, d'Orb.
Pulvinulina Patagonica (d'Orb.).
Cymbalopora bulloides (d'Orb.).
Chilostomella ovoidea, Reuss.†

It is doubtful—(1) whether some of these, if not all, can and do live at the bottom as well as near the surface;—(2) whether or no there are differences of structure in two series of each species, one for "pelagic," and one for deep-water existence;—and (3) whether some have only a temporary breeding-time during "pelagic" life. Doubtless an enormous variety of other Foraminifera do exist on the sea-bed, often at very great depths; and there is no reason to doubt that those of the Chalk were chiefly of this kind.

* These are known in the Chalk.

† See H. B. Brady's 'Report,' etc., pp. x, and following, for his remarks on the "pelagic" Foraminifera, with references to other observers and writers on the same subject.

Coccoliths, etc.—Mr. Sorby found, some years ago, that certain specimens of Chalk consisted almost wholly of *Globigerinæ* (90 per cent.); other parts of the Chalk have fewer of these, but more *Textulariæ*, or other forms; and in some cases *Inoceramus* prisms or Pentacrinite ossicles, etc., form most of the mass. In all cases, however, the fine granules are present, which in some cases seem to be amorphous particles, or inorganic (as indeed they all were thought to be by Ansted and early observers), but they mostly prove to be minute organic bodies of definite shape and size, now known as Coccoliths. Whether or no any chemical precipitates, of a calcareous nature, have given origin to some of the particles, has not yet been decided.

These minute organic bodies (the largest less than $\frac{1}{1000}$th of an inch in diameter) are oval (rarely circular) double discs, like a shirt-stud. Sorby, Huxley, Wallich, Carter, Schmidt, and others have studied them; and Dr. Wallich has compared the separate views, and repeated his own, so that by referring to his paper * much can be seen at once. He regards these little Coccoliths as being peculiar calcareous symmetrical bodies set in on the outside of the small sarcodic bodies (coccospheres) which he discovered floating in the ocean, and having sometimes the shapes of some Foraminifera, such as *Textularia*, etc. Huxley regarded the Coccoliths as individual distinct organisms, and Carter referred to them as sporangial bodies of some *Algæ* such as *Melobesia*. Huxley and Schmidt lay stress on the granular zone or ring occurring sometimes between the two discs; and indeed Schmidt regards it as very important and equivalent to the ring on the base of certain Rhabdoliths common in the Chalk of some places. These also are minute and shapely bodies, found in sea-muds with the Coccoliths.† They are club-shaped, but varied, and have been found, attached by their broad bases to a small spherical body, floating in the sea (rhabdosphere, Wyville Thomson). Some regard them as being probably of vegetable alliance. Recurring to the granular rings of the Coccoliths, we find that such little organisms were observed in the Chalk years ago by Ehrenberg, and figured in his magnificent 'Mikrogeologie,' and that they were seen also long since by the Rev. J. B. Reade in the English Chalk.‡ In those days they were quite misunderstood, and there still remains much to be known about them.§

Flint.—Whether calcareous or siliceous originally, the particles, fragments, and complete organisms, large and small, composing the Chalk, are in many instances found to be more or less changed into, or to be imbedded in the flint which is so abundant as nodules and bands in some strata of the Chalk. There are some permanent

* 'Ann. and Mag. Nat. Hist.,' ser. 4, vol. xix, p. 342, etc.

† *Ib.*, ser. 4, vol. x, p. 359, etc.

‡ See Mantell's 'Wonders of Geology,' 7th ed. 1858, vol. ii, p. 953, fig. 213.

§ Some very important observations on Coccoliths (with figures) have been given by Dr. W. J. Sollas in the 'Geological Magazine,' Dec. 2, vol. iii, 1876, pp. 540-542, pl. 21.

exceptions, such as Echinoderms, Monomyarians, and some other calcareous organisms, which have not become silicified either in the Chalk or in any other limestone which has been (as is often the case) converted into flint or chert. My own views on this subject have been given in full in the 'Proceedings of the Geologists' Association'* with references supplied for the study of many writings on the same matter.† Numerous other observers have since then published the results of their experiments and researches, notably Dr. Wallich and Prof. Sollas, whose memoirs must be carefully looked to by students. The condition in which silica (the general name for quartz, chalcedony, flint, jasper, etc.) occurs in the fossil Sponges of the Chalk has been carefully defined by Sollas and Hinde in their works already alluded to; and the former has suggested that three stages or processes in the silicification of Chalk into flint-nodules are clearly traceable.‡ Mr. J. Allen Brown has worked out, for the Ealing Microscopical and Natural History Society, a *résumé* of the views of these and other writers down to 1882,§ which is very suggestive for those wishing to take up the subject. There are many points to be considered—particularly (I) the actual relationship of the visible organisms in the flint (and usually these are abundant) to those constituting the chalk,—(II) the actual silicification or non-silicification of these several organic particles or small organisms—so also of the oolitic and other constituents in other silicified limestones,—(III) the condition of the silica with reference to its crystalline or colloidal character,—(IV) the successive coatings, layers, or replacements of such silica,—(V) the probable origin of the silica, from (1) siliciferous water of springs and worn coasts, (2) from dissolved Polycystines and spicules, and (3) from hydrated, colloid, or soluble silica, even now found in some rocks,—(VI) its relation to carbonaceous matter, either in living organisms or in dead matter,—(VII) how the calcareous matter has been removed before or during its replacement by the silica,—and (VIII) how much, indeed, of the silicification in Chalk and other limestones (for every limestone has its siliceous nodules in one form or another) has been due to (1) coating, and to (2) replacement by infiltrating water, how much to the (3) chemical combination of silica with organic matter, and how much to the (4) agglutination (so to speak) of gelatinous or colloidal silica, either specially or indiscriminately, to the calcareous and other constituents of the mass.

The frequent occurrence, in hollow flints, of a white siliceous meal, consisting mainly of loose *silicified* Ostracoda and Foraminifera, formerly calcareous, with Polycystina (Wallich, quoted above) and spicula which were presumedly always siliceous, has not yet been satisfactorily accounted for to my mind. The remarkably fine specimens of hollow flints, with mammillated chalcedony and

* Vol. iv, 1876, pp. 439-458.
† See also Hudleston on Flint, 'Proceed. Geol. Assoc.,' vol. vii, 1881, p. 183.
‡ 'Brit. Assoc. Report' for 1881, etc.
§ "Some Notes on Flint," etc.

sometimes quartz crystals coating the interiors, which this Society possesses by the gift of the late Mrs. W. Stuart, who collected them at the digging of the Watford Tunnel on the London and North-Western Railway, ought to incite some of the Members of the Hertfordshire Natural History Society to the study of *Flint*.

Conclusion.—I have now noted most of the features of the Chalk; and, if I have not made them very clear, I have, at least, opened out lines of thought worth the study of those who have time to go into them. The formation of the Chalk geographically offers to you an interesting chapter in Geology, such as may be read in all the great systems of strata up to the present day. In the materials which form the Chalk you have an extensive and successional Natural History to look at. In it you have some of nearly every group of animals to study, except the high-class Vertebrata; but Birds must have existed even then, and also Mammals, because they lived before that time, though they could rarely be found in the deep sea. Leaving these matters for your further consideration, I may only remark that you have a very fine field of study in your own Chalk of Hertfordshire.

XVII.

ANNIVERSARY ADDRESS.

By the President, the Right Honourable the Earl Cowper, K.G.

Delivered at the Annual Meeting, 17th February, 1885, at Watford.

Ladies and Gentlemen,—

I believe it is now my duty to give you an address. I will begin by a story of Sydney Smith. Many speakers and writers before me have been helped out of their difficulties by an anecdote about that distinguished man. Sydney Smith was induced to visit a phrenologist, who, after feeling all his bumps and carefully observing his head, said: "This gentleman is a born naturalist. He has probably written largely on ornithology, or perhaps has made deep scientific inquiries into the nature and habits of fishes." Upon this Sydney Smith looked up at him and said: "Sir, I don't know the difference between a bird and a fish." It is hardly an exaggeration to confess that this is the case with me. You may perhaps say: "Then how do you come to fill your present position?" The fact is, I took it because it was offered to me, and because, though I know nothing of Natural History myself, I yet feel that it is a most useful study, and that this is a most excellent Society. I feel at this moment inclined to apologise for having taken it, and sorry for myself and sorry for you that I did so. But I assure you that my regard for this Society is genuine. It is desirable to encourage those who have a turn for observing nature, and to give them an opening for the result of their studies. It is a great thing to teach the eye to observe, and this comes as you know very much by practice. It is also a great thing that a man should learn early the habit of committing his thoughts and his observations to paper in easy and clear language. I believe that an immense amount of good thought is lost to the world from want of this power which is so easily acquired in early life. I was talking not long ago to the editor of one of our principal magazines, and he told me that it was surprising how many papers full of original and sometimes profound thought he had to reject from their being put together in a hopelessly confused and unintelligible manner.

These two things—how to observe and how to record our observations—are taught by our Society, and it was my wish to encourage the Society that induced me to become President. Having accepted the office, which in other respects is not an onerous one, I found that it involved one very serious duty, that of making an address.

I was prevented by illness last year from doing this, and my place was most ably and efficiently filled by Mr. Evans. I wish he could fill it now. But I could not say that I was ill this time, and I therefore resolved to appear, to open the proceedings with such remarks as might occur to me, and to ask him, and any others who would be sufficiently good-natured, to back me up, in order that if your principal dish fails you may have something else to fall back upon.

Having screwed up my courage to the task, and begun seriously to consider what remarks I should make, the first thing that occurs to me is to become painfully impressed with my own ignorance. Geology, botany, meteorology, ornithology, entomology, zoology, alas! I fear that I have nothing but the smallest smattering of any one of them, of most of them not even that. What have I been learning all my life? Of course, while I was at school I was learning Greek and Latin. But what have I been doing since beyond gradually forgetting these? To do myself justice, I must own that I have always been fond of reading. I have read a certain amount of history, and I have followed more or less carefully the politics of each day for the last quarter of a century.

But what connexion can this have with natural history? Some people have said that all sciences will be found to be in reality connected together if you trace them to their source; that there are certain rules which apply to them all; that in the same way as heat and motion and force are in reality the same thing, so all the sciences will be found to be one. That all branches of science are connected together is indicated by the manner in which excellence in one branch leads to general proficiency. This last cannot be better shown than in the career of one who was accustomed to take a prominent part in your proceedings. I refer to the late Mr. Gwyn Jeffreys. He was a man whose loss will be felt by many others besides ourselves. But I will not allude to his merits further than to illustrate my subject. He himself modestly told us some time ago that he was a man of one book. This is an exaggerated statement, but he had made his great mark by his deep and intimate acquaintance with every detail of the science of conchology. Knowing this one branch thoroughly gave him almost without seeking it a very good acquaintance with the rest of science. Even more than this. It was, I think, by knowing one branch of science so completely, and by having gained such distinction in it that he had trained his intellect in such a way as to be able so admirably to perform all his duties as a citizen, that he acquired so good a reputation in every walk of life, and is so universally regretted.

If then all sciences are thus connected, perhaps a study of the characters, the actions, and the government of men may after all have some connexion with those studies which it is the province of our Society to encourage. It would be hopeless for me to attempt to show the connexion, but there is a tendency which we all have, and which I confess I have very strongly myself, calculated if we give ourselves up to it to furnish us with some hints towards the manner in which the connecting point may be approached. I mean the tendency to comparison—the impulse to illustrate one science by another—the habit of groping after some sort of resemblance between things apparently the most unlike one another — the tendency to make similes and to follow analogies.

I propose this evening, in the few words which I have to say to you, to let my fancy run upon those points of resemblance to human actions which are presented by some of the commonest and most obvious objects which occur to us in the study of natural history.

I will begin with an animal of which we are none of us particularly fond, and with which it is perhaps not pleasant to be compared—I mean the rat. One idea of the history of England is that the island was first occupied by the Ancient Britons, then by the Romans for some years, that then the Saxons drove out the original inhabitants, and that they were in their turn conquered though not driven out by the Normans, and that we have never been conquered since and never mean to be. All this time the rats have been having a little English history of their own quite independent of ours, and quite as important to them as ours has been to us. The old English black rat is thought by some to have been indigenous to our country; by others he is said to have come over from abroad, and they go so far as to fix the time of his arrival at about the date of the Norman Conquest. He does not, according to this last theory, appear to have found any previous rats to drive out, so that if he was not an original inhabitant he may be considered as an immigrant rather than an invader. For many centuries he remained undisputed tenant behind our wainscots and in our barns and our drains. But about two hundred years ago the Norwegian brown rat found his way over, and has been gradually driving out the other ever since. The struggle has been curiously like the old struggle between the Saxons and the Celts. The little black rat still holds his own in certain places. He still maintains his existence and his independence in the neighbourhood of the Tower of London, and in certain of our breweries, and if one of the large brown rats appears there he is set upon by overwhelming numbers and destroyed. But the stronger race is gradually

encroaching, and in course of time will as surely cause the extinction of the other as the white man has caused the extinction of the Red Indians in the eastern States of America, and is rapidly doing the same thing to the natives of New Zealand.

Another instance of the gradual driving out of one race by another is supposed by some to be going on at this very moment in our fields and hedges. The red-legged partridge is in many places gradually supplanting the common English partridge. In other places he gains ground for a time, but afterwards disappears. It is difficult to say, supposing any game still to exist in these islands in another hundred years, which breed of the two will be driven over the heads of our descendants or walked up by them in their turnips and stubbles, whether it is to be a case of successful invasion and extirpation of the original inhabitants, like that by the Saxons in England and by the white men in America, or whether it will resemble the history of the Spaniards and the Moors. The Spaniards, as you may remember, were in the middle ages driven by the Mahomedan invaders into the northern mountains of their own country, but during several succeeding centuries they gradually regained their ground from the intruders, and ended by altogether expelling them.

But it is not only in their emigrations and their territorial conquests that men and the lower animals resemble one another. We know how much, at all events in the case of domestic animals, the breed may be improved by the introduction of a little fresh blood. This holds good even in the case of animals which have been only half domesticated, like deer in a park. I have often thought that history teaches us the same lesson with regard to men, and that all the great nations which have arisen one after the other have owed their great qualities to a happy mixture of race. It is, I think, necessary in the case of men as in that of other animals that the new blood introduced should not be too different from the old. For instance, no great nation could ever be formed by a cross between a white man and the Negro or the Red Indian. But let us look back through past ages and see whether what I have suggested is not on the whole confirmed by example. In the first place I must admit that the example of the Jew is against me. But the greatness of the Jews was of an altogether peculiar kind. Indeed their whole history is so singular and so unlike any other that it may perhaps be considered as a thing apart. The Greeks were evidently a mixed people. Their traditions pointed to a foreign conquest and a dominant race, and the description of the fair-haired heroes of the Homeric age, if not altogether suggested by poetic fancy,

would seem to imply that the dominant race was of northern origin. The Romans, according to their own tradition, were descended from the scum of all the surrounding nations and invited by Romulus to people his city, and, even if we reject tradition, their geographical position on the border between two such different races as the Latins and the Etrurians would indicate mixed blood. The modern French were formed by the infusion of a German tribe into a Celtic population, and we know how our own English breed was enlivened and improved by large importations of Danes and Normans.

It has often been a matter of speculation what will be the future of the world. Past experience tells us that each great race has its day of pre-eminence followed by a gradual decline. What is to happen when the English and the Germans and the French have told their story and finished their career? There does not at present appear to be any race to succeed them, for the Americans are only a repetition of the English, with the same virtues and the same faults. Perhaps some new and at present unexpected combination may take place—some fresh breed may be formed out of old elements—the future may be with some mighty people not yet created, as different from any of its component parts as gunpowder is from either saltpetre or sulphur or charcoal.

You will think by this time that I have advanced rather far into the regions of fancy, and that I am unduly making up for my want of knowledge of natural history by drawing upon my imagination. I return to my original intention of seeking an analogy to human affairs in the government and the conduct of the animal world. Nowhere do we find more suggested to us in this direction than in a study of ants and bees. "Go to the ant, consider her ways, and be wise" is a precept which has been addressed to the sluggard. It might perhaps be addressed to the politician. Many useful, but often forgotten moral lessons may be drawn from observing the habits of these insects. We see the evils of slavery, for, as you know, certain species of ants have slaves, and become so helpless and so entirely dependent in consequence that they cannot even clean or feed themselves, and if their slaves left them they would starve to death. The wars and battles of these little creatures are full of interest. We see the advantage of courage and skill over mere brute force. We may draw the lesson that be a nation ever so industrious and orderly, ever so capable of collecting food, of building itself a comfortable and luxurious abode, if it allows its fighting powers to decay, it will subject itself to the most frightful calamities.

These and a hundred lessons more may be taught by the ant. I turn to the bee. My studies in natural history have, as I have told you, been few and desultory. But of the few books which I have come across upon the subject, there is one of absorbing interest. I mean Huber 'On Bees.' I have a great fancy for this book; perhaps, because it is one of the first I read of the kind. It is rather an old book, and I have no doubt that its information would be very stale to most of my present audience, and that a great deal has been discovered since. But I am sure no book that has been written upon the subject carries the reader along in the same manner. Every detail is confirmed by experiment, and every experiment is related in the minutest and most circumstantial manner; but you often feel as if you were reading, not an account of the habits of insects, but a chapter from a history of the middle ages, or a poem, or a romance. There is a description of a fight between two queens in a hive, with all the other bees standing round in a circle, which is as spirited as the fight between Herminius and Mamilius in Macaulay's 'Lays,' or as the tournament in 'Ivanhoe.' The account of the reception of a new queen and her passage through her dominions, with her subjects drawing themselves obsequiously on one side, or presenting their tribute of royal honey, is like a scene from 'Kenilworth.' The behaviour of the bees when they find it necessary on certain occasions to oppose the destructive instinct of their monarch, the respectful but firm manner in which they restrain her movements, never using their stings, and preserving as far as possible the outward forms of respect, remind us of some of the noblest and most patriotic of our ancestors. Then there is a most graphic picture by an eye-witness of a massacre of the drones, such as yearly takes place in every hive — the gradually-increasing commotion among the working bees; the insults offered to the drones in numerous individual instances; the growing alarm of the poor drones, who gradually collect together at the bottom of the hive; the entry of the working bees among the unarmed crowd; the rapid and indiscriminate slaughter; the ghastly calm which succeeds; and the subsequent removal of the dead bodies. One fancies oneself reading of the Sicilian Vespers or St. Bartholomew's Day. I will not detain you by an account of the emigration of the surplus population or the founding of new colonies, for these are familiar incidents. I will only say that I wish all our own emigrations were conducted in the same orderly manner, and that it was as easy to remedy overcrowding among men as among bees.

Well, ladies and gentlemen, these experiments and observations

give rise to strange and serious thoughts. Even when read in a book, and much more of course when actually seen, each event which I have described appears to be the result of deliberate will or momentary passion in the actors. And yet if we follow the history of a bee-hive for some continuous time, or if we observe different bee-hives at the same time, we see that all these things which appear to be the result of individual action occur in a uniform order and by a fixed rule. Before every swarm, except the first, the queen, who is to lead it, tries desperately to destroy the young queens in their cells, and is respectfully but firmly prevented by her subjects from doing so. Every year and almost on the same day there is a massacre of the drones in every hive. After considering these things I feel almost inclined to agree with Mr. Buckle that human history may perhaps, also, be reduced to fixed rules, and that the emigrations and conquests, the rebellions and the wars, the massacres and the changes of constitution in different countries which compose that history, may occur in accordance with some well-ordered plan which we do not see far enough to explain. I know that there are other moments in which this seems to be an absurdity. When we read the lives of great men like Alexander, Cæsar, Cromwell, or Napoleon—still more when we find a feeble man like Louis the Sixteenth upon the throne at a critical period, and think how differently things would have turned out if the man had been wise and strong—we come back to the conclusion that individual character does affect the course of events.

In these speculations, as in so many others, there are distinct trains of thought, each of which seems to be well founded and to lead to a sensible conclusion, but of which the conclusions are diametrically opposite. If this were a disquisition upon history I should feel tempted to enlarge upon this point, as it is one of most absorbing interest. In pursuing my subject I might be led on from history to moral philosophy, and from that to theology, till I found myself involved in the old and never-ending dispute about predestination and free will. I am certainly not going to discuss the subject of predestination. The most sensible remark that I ever heard about it was one that was made by an Oxford under-graduate when asked in an examination paper what his views were upon the subject: "Predestination is the thief of time." It has certainly caused great waste of time by those who have discussed it.

I will drift no further into speculation. That I have drifted into it as far as I have is from want of anything else to give you. If I could have presented you with one single useful result of

observation or experiment I should have felt very proud and happy, and should have considered it far better than all the speculations in the world.

I will now bring my observations to a close. One thing I will at all events keep clear of, and I wish that others who know far more of natural history and natural science than myself would do the same. It is now too much the custom to make every lecture —almost every conversation—on these subjects a pretence for plunging into the most awful and most sacred mysteries. Ground on which angels may well fear to tread is rushed into by everybody who has read a little of Darwin or tried to read a little of Herbert Spencer. I do not wish to be misunderstood. I am in favour of free discussion on all and every subject. I do not admire the plan of the Papal Syllabus. To issue a list of books that are not to be read is only to call attention to them. Besides this, to discourage free discussion is at once to admit that to allow it would be injurious to your cause. All I wish is that the discussion should be conducted with due reverence, and that it should be considered necessary before engaging in it, not merely to have a smattering of knowledge, but to have deeply and patiently and anxiously studied the whole question. I think you have done very wisely hitherto in keeping clear of theological and religious speculation, and I have carefully followed the example. I will now, as I said, bring my observations to a close. I have determined that if I cannot be instructive, I will at least avoid being tedious. I thank you most cordially for the indulgent manner in which you have received me, and I hope that next year you may hear within these walls a more instructive and more practical address.

XVIII.

LIST OF WORKS ON THE GEOLOGY OF HERTFORDSHIRE, 1874–83.

By John Hopkinson, F.L.S., F.G.S., etc.

Read at Hertford, 19th February, 1885.

In the first volume of the 'Transactions' of our Society * is a list, compiled by Mr. W. Whitaker, of works on the geology of Hertfordshire to the end of the year 1873. The following is a supplementary list of books and memoirs treating of the geology of our county, or referring more or less to it, which have been published during the first decade which has since elapsed.† A considerable number of these consist of memoirs which have appeared in our own 'Transactions,' and I have included the reports of about twenty of our Field Meetings at which information on local geology has been imparted.

In some of our county histories, not referred to in the former list, there is an occasional reference to geological phenomena (soils, mineral springs, etc.). The earlier of these only are of interest as illustrations of the crude state of geological knowledge at the period at which they were written, our topographical and historical writers having devoted very little attention to the geology of our county.

I have not included in the list Salmon's 'History of Hertfordshire' (1728). After saying that "The county is to be considered both in its natural and civil state; the Earth and its Inhabitants," he merely says of "the Earth" (p. 1): "The Soil is none of the fruitfullest . . . . The Arable hath generally too much Gravel or too much Clay." And, except in recommending "St. Foyne where the Earth is Chalky," I think the only other remark bearing on the geology of the county which he makes is in his account of Moor Park, the present seat of Lord Ebury, in which he says, in referring to alterations to "More House" (p. 110): "in digging were found Veins of Sea Sand with Musscles in it." Clutterbuck is our first historian who adds materially to our knowledge of the geology of the county. In the first volume of his 'History' (1815) he gives a brief account of the Totternhoe Stone and of the Hertfordshire conglomerate, the first notice of the latter, I believe, except the curious account given in a work dated 1756, relating to the Natural History of Hertfordshire, as quoted in Crawley's 'Guide to Hertfordshire' (1880). Crawley does not give the title of the work nor the author's name, but the following is the quotation (p. 9 *of Introduction*): "The surface of every ploughed field is covered with innumerable small Stones of the flinty kind generally,

* 'Trans. Watford Nat. Hist. Soc.,' Vol. I, part 3, p. 78.—1876.

† I am indebted to Mr. Whitaker and to Mr. W. Topley for valuable assistance in the compilation of this list, they having made it more complete by the addition of twelve memoirs which I had overlooked. I shall be glad to be informed of any omissions there may still be in it.

and many of them inimitably variegated with various Colours and Figures. The Plumb Pudding stone may also be called a native of this County. Many of this kind which are found here will weigh twenty or thirty pounds, and will bear as fine a polish as Glass, and far exceed in beauty all the Marble I ever saw. In many of their gravel pits are also found clear, transparent pebbles, generally not exceeding the size of chestnuts, and seldom less than a pea, but as clear as a drop of water, and extremely hard. These cut and polish as fine as a Diamond, and when set upon a good foil appear extremely brilliant, and are capable of being made into Rings, Buttons, and various other Toys."

In Mr. Whitaker's list 58 works are enumerated, and in the following supplementary list the numbering of the memoirs is continued from that, bringing up the total to 136. To this number the county histories, and a few other works in which reference is made to the geology of Hertfordshire, published before 1874, have to be added. To these additions, given as an appendix, a different series of numbers is prefixed.

1874.

59. Fordham, H. G. Notes on the Structure sometimes developed in Chalk. [Ashwell.] *Quart. Journ. Geol. Soc.* vol. xxx, p. 43.

60. [Lobley, J. L.] Excursion to Hatfield. *Proc. Geol. Assoc.* vol. iii, No. 6, p. 240.

61. Sixth Report of the Commissioners appointed in 1868 to enquire into the best means of preventing the pollution of Rivers. The Domestic Water-supply of Great Britain. Folio. London. (Numerous references to Herts.)

1875.

62. Brett, Dr. A. T. Mineral Spring at Watford. *Trans. Watford Nat. Hist. Soc.* vol. i, part 2, p. 63.

63. Fordham, H. G. On a Collection of Fossils from the Upper Greensand of Morden, Cambridgeshire [also Ashwell, Herts]. *Proc. Geol. Assoc.* vol. iv, No. 2, p. 150.

64. [Hopkinson, J.] Excursion to Watford. *Proc. Geol. Assoc.* vol. iv, No. 5, p. 284. Field Meeting, 1st May, 1875. [Berry Wood.] *Trans. Watford Nat. Hist. Soc.* vol. i, part 3, p. xv (1876).

65. Lobley, J. L. The Cretaceous Rocks of England. *Trans. Watford Nat. Hist. Soc.* vol. i, part 1, p. 1.

66. Whitaker, W. Guide to the Geology of London and the Neighbourhood. (*Geol. Surv.*) 8vo. London. (Ed. 2, 1875; Ed. 3, 1880; Ed. 4, 1884.)

1876.

67. Barrois, Dr. C. Recherches sur le terrain crétacé supérieur de l'Angleterre et de l'Irlande. (Herts, pp. 150–153.) 4to. Lisle.

68. Clutterbuck, Rev. J. C. The Geology and Water Supply of the Neighbourhood of Watford. *Trans. Watford Nat. Hist. Soc.* vol. i, part 5, p. 125.

69. Evans, J. On the Percolation of the Rainfall on Absorbent Soils. *Proc. Inst. Civ. Eng.* vol. xlv, p. 208.

70. Greg, R. P. Third Report of the Committee . . . . appointed for the purpose of recording . . . . the Erratic Blocks of England, Wales, and Ireland. . . . . By the Rev. H. W. Crosskey. *Rep. Brit. Assoc.* for 1875, p. 82. (Herts, by R. P. Greg, p. 86.)

71. [Hopkinson, J.] Field Meeting, 29th May, 1875. Colne Valley Waterworks, Bushey Kiln, and Watford Heath Kiln. *Trans. Watford Nat. Hist. Soc.* vol. i, part 4, p xviii.

72. [Hopkinson, J.] Field Meeting, 19th June, 1876. Aldbury, Ashridge Park, and Berkhampstead. *Ib.* p. xxi.

73. [Hopkinson, J.] Excursion to Hatfield. *Proc. Geol. Assoc.* vol. iv, No. 8, p. 518. Field Meeting, 13th May, 1876. Hatfield Park. *Trans. Watford Nat. Hist. Soc.* vol. i, part 6, p. xxxvii (1877).

74. Morris, Prof. J. The Physical Structure of the London Basin, considered in its Relation to the Geology of the Neighbourhood of Watford. *Trans. Watford Nat. Hist. Soc.* vol. i, part 4, p. 89.

75. Penning, W. H. Notes on the Physical Geology of East Anglia during the Glacial Period. *Quart. Journ. Geol. Soc.* vol. xxxii, p. 191.

76. Pryor, R. A. On the supposed Chalybeate Spring at Watford, and on other Medicinal Waters in Herts. *Trans. Watford Nat. Hist. Soc.* vol. i, part 4, p. 109.

77. Verini, W. Section of Strata passed through in boring at the Colne Valley Waterworks. *Ib.* part 5, p. 135.

78. Whitaker, W. List of Works on the Geology of Hertfordshire. *Ib.* part 3, p. 78.

79. Wiehmann, A. Ueber Puddingstein. *N. Jahrb.* Heft ix, p. 907.

1877.

80. Evans, J. The Hertfordshire Bourne. *Trans. Watford Nat. Hist. Soc.* vol. i, part 6, p. 137.

81. Greg, R. P. Boulders in the Neighbourhood of Buntingford, Herts. *Ib.* part 7, p. 172.

82. Homersham, L. C. [Remarks on Hertfordshire in] Discussion on Mr. Lucas' paper on Hydrogeology. *Trans. Inst. Surveyors*, vol. ix, pt. 9, p. 221, and section.

83. [Hopkinson, J.] Field Meeting, 29th April, 1876. St. Albans. *Trans. Watford Nat. Hist. Soc.* vol. i, part 6, p. xxxv.

84. [Hopkinson, J.] Field Meeting, 17th June, 1876. Boxmoor, Bennet's End, and Nash Mills. *Ib.* part 7, p. xli.

85. Lobley, J. L. The Eocenes of England and their Extension in Hertfordshire. *Ib.* p. 161.

86. Whitaker, W., and W. H. Penning. Section of the London Basin from North to South; . . . . into Hertfordshire, to the outcrop of the Chalk in the Valley of the Ash at Widford. (Sheet 120 of the Horizontal Sections of the *Geological Survey*.)

1878.

87. Ansted, D. Water and Water-supply, chiefly in reference to the British Islands:—Surface Waters. 8vo. London.

88. Clutterbuck, Rev. J. C. The Products of Hertfordshire. *Trans. Watford Nat. Hist. Soc.* vol ii, part 1, p. 41.

89. Clutterbuck, R. The Coprolite Beds at Hinxworth. *Ib.* vol. i, part 9, p. 238.

90. Fordham, H. G. Fifth Report of the Committee . . . . . for the purpose of recording . . . . the Erratic Blocks of England, Wales, and Ireland . . . . By the Rev. H. W. Crosskey. *Rep. Brit. Assoc.* for 1877. (Herts, by H. G. Fordham, pp. 84-85.)

91. [Hopkinson, J.] Field Meeting, 16th June, 1877. Hitchin. *Trans. Watford Nat. Hist. Soc.* vol. i, part 9, p. lxi.

92. [Hopkinson, J.] Excursion to Hertford and Ware. *Proc. Geol. Assoc.* vol. v, No. 8, p. 519. Field Meeting, 16th June, 1878. Hertford and Ware. *Trans. Watford Nat. Hist. Soc.* vol. ii, part 4, p. xxvi (1879).

93. Lucas, J. Hydrogeological Survey. Sheet 2. Scale 1 inch to a mile. (Herts in N.W. corner.)

94. Lucas, J. The Hydrogeology of Middlesex and part of Hertfordshire . . . . *Trans. Inst. Surv.* vol. x, part 12, p. 279.

95. Penning, W. H. Section across the Chalk of Hertfordshire from three miles eastward of Ware, ... through the Tertiary outlier of Sacomb and Cutting Hill by Baldock . . . . (Sheet 121 [cont. of sheet 120] of the Horizontal Sections of the *Geological Survey.*)

96. Whitaker, W., W. H. Penning, W. H. Dalton, and F. J. Bennett. The Geology of the N.W. part of Essex and the N.E. part of Herts, with parts of Cambridge and Suffolk. (Explanation of Sheet 47 of the Map of the *Geological Survey.*) 8vo. London.

1879.

97. Barrow, J. On large and deep Bore-holes with the Diamond Drill. *Trans. S. Wales Inst. Eng.* vol. xi, No. 7, p. 315. (Ware, pp. 322-324, plates 50, 51.)

98. Dawkins, Prof. W. B. On the Range of the Mammoth in Space and Time. *Quart. Journ. Geol. Soc.* vol. xxxv, p. 138. (Refers to Bricket Wood, p. 139.)

99. Etheridge, R. Position of the Silurian Rocks in Herts. *The Times*, 19th May; and *Geol. Mag.* decade 2, vol. vi, p. 286.

100. Etheridge, R. The Position of the Silurian, Devonian, and Carboniferous Rocks in the London Area. *Pop. Sci. Review*, new series, vol. iii, p. 279.

101. Godwin-Austen, R. A. C. Palæozoic Rocks in the South-east of England. *Nature*, vol. xx, p. 547.

102. Godwin-Austen, R. A. C. On some Further Evidence as to the Range of the Palæozoic Rocks beneath the South-east of England. *Rep. Brit. Assoc.* for 1879, p. 227.

103. [Hopkinson, J.] Field Meeting, 3rd July, 1878. Moor Park. *Trans. Watford Nat. Hist. Soc.* vol. ii, part 4, p. xxix.

104. Hopkinson, J., and W. Whitaker. Excursion to Watford. *Proc. Geol. Assoc.* vol. vi, No. 5, p. 191. Field Meeting, 17th May, 1879. Watford. *Trans. Watford Nat. Hist. Soc.* vol. ii, part 6, p. xlv.

105. Hull, E. The Discovery of Upper Silurian Rocks under the Chalk of Hertfordshire. *Geol. Mag.* decade 2, vol. vi, p. 335.

106. Toplis, F. Suggestions for dividing England and Wales into Watershed Districts. *Journ. Soc. Arts*, vol. xxvii, p. 696. (Thames District [including Herts], p. 705.)

107. Woodward, H. B. The Mammoth not Pre-Glacial in Britain. *Geol. Mag.* dec. ii, vol. vi, p. 235.

1880.

108. Clutterbuck, Rev. J. C. The Oxhey Cutting on the London and North-Western Railway, Watford. *Trans. Watford Nat. Hist. Soc.* vol. ii, part 7, p. 250.

109. Fordham, H. G. On a Boulder now in the Garden of the Royston Institute. *Ib.* p. 249.

110. Harrison, W. J. On deep Borings in the South-east of England. *Midland Naturalist*, vol. iii, p. 188.

111. Hopkinson, J. On the Recent Discovery of Silurian Rocks in Hertfordshire, and their Relation to the Water-bearing Strata of the London Basin. *Trans. Watford Nat. Hist. Soc.* vol. ii, part 7, p. 241.

112. [Hopkinson, J.] Field Meeting, 25th June, 1879. Tewin Water, Digswell, and Ayot Green, Welwyn. *Ib.* p. lvi.

1881.

113. Brett, Dr. A. T. Notes on a Cutting in Hamper Mill Lane, Watford. *Trans. Herts Nat. Hist. Soc.* vol. i, part 4, p. xxxii.

114. Elsden, J. V. The Post-Tertiary Deposits of Hertfordshire. *Ib.* part 3, p. 103. (Observations on Mr. Elsden's paper by Dr. J. Evans. *Ib.* part 4, p. xxix.)

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116. Hopkinson, J. Excursion to Totternhoe, Kensworth, and Luton. *Proc. Geol. Assoc.* vol. vii, No. 3, p. 191. Field Meeting, 25th June, 1881. Totternhoe, Kensworth, and Luton. *Trans. Herts Nat. Hist. Soc.* vol. i, part 8, p. lxv (1882).

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123. Harrison, W. J. Geology of the Counties of England . . . . (Herts, pp. 120–124.) 8vo. London.

124. [Hopkinson, J.] Field Meeting, 15th May, 1880. Radlett. *Trans. Herts Nat. Hist. Soc.* vol. i, part 8, p. xxxiii.

125. [Hopkinson, J.] Field Meeting, 12th June, 1880. Ashridge. *Ib.* p. xxxvi.

126. [Hopkinson, J.] Field Meeting, 10th July, 1880. Cole Green, Woolmers, Essendon, and Hatfield Park. *Ib.* p. xxxviii.

127. [Hopkinson, J.] Field Meeting, 7th May, 1881. The Bourne Valley, Boxmoor. *Ib.* p. lviii.

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130. Croft, R. B. Notes on the River Lea below Hertford. *Trans. Herts Nat. Hist. Soc.* vol. ii, part 7, p. 243. (Geology, pp. 247, 248.)

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132. [Fordham, H. G., and J. Hopkinson.] Field Meeting, 18th July, 1882. Royston. *Ib.* part 5, p. xxx.

133. Greg, R. P., and R. B. Croft. Notes on the Upper Portion of the River Rib and its affluent the Quin. *Ib.* part 3, p. 126. (Geology, p. 129.)

134. Hopkinson, J., [and Dr. J. Evans]. Excursion to Berkhampstead and Bourne End. *Proc. Geol. Assoc.* vol. viii, No. 3, p. 117.

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136. Puller, A. G. Notes on the River Rib from Standon to its Junction with the Lea. *Ib.* part 3, p. 131. (Geology, pp. 134, 135.)

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1598.

a1. Norden, J. Speculi Britanniæ Pars. The description of Hartfordshire. ("Concerning the Soyle," p. 1; "a kinde of chalke" at "Hitching," p. 18.) 4to. London. (Ed. 2, 1637; Ed. 3, 1723.)

1700.

a2. Chauncy, Sir H. T. The Historical Antiquities of Hertfordshire. ("The Soil," p. 1.) Folio. London. (Ed. 2, 1826, in 2 vols. 8vo. Bishop's Stortford.)

1720.

a3. [Cox, T.] Magna Britannia et Hibernia, Antiqua et Nova. (Soil, medicinal waters, and petrifying springs of Herts, vol. ii, pp. 1016, 1017.) 4to. London.

1795.

a4. Walker, D. General View of the Agriculture of the County of Hertford. 4to. London. ("Soil" and "Strata," pp. 10, 11.)

1796.

a5. Lysons, Rev. D. The Environs of London..... vol. iv. Counties of Herts, Essex, and Kent. (Soil of Chipping Barnet, p. 1; East Barnet, p 9; Elstree, p. 24; Totteridge, p. 40. Mineral Spring at Chipping Barnet, p. 8.) 4to. London.

1805.

a6. Brayley, E. W., [and J. Britton]. Beauties of England and Wales. Vol. vii. Hertfordshire. (Soils, pp. 10-12. Mineral waters, p. 19.) 8vo. London.

180 .

a7. [Cooke, G. A.] A Topographical and Statistical Description of the County of Hertford. ("Climate and Soil," pp. 21-24.) 12mo. London.*

1815.

a8. Clutterbuck, R. The History and Antiquities of the County of Hertford. ("Natural History and Climate" [including Geology], vol. i, p. iii.) 3 vols. Folio. London.

1836.

a9. Fitton, Dr. W. H. Observations on some of the Strata between the Chalk and the Oxford Oolite, in the South-east of England. *Trans. Geol. Soc.* ser. 2, vol. iv, p. 103. (Herts, p. 305. Map of part of the South-east of England [including Herts], plate 9.)

1849.

a10. Coleman, Rev. W. H. Flora Hertfordiensis .... by the Rev. R. H. Webb and the Rev. W. H. Coleman. (Physical Geography and Geology [by Coleman], pp. xxix-xliv.) 12mo. London and Hertford.

* A volume of Cooke's 'Topographical Library of Great Britain.' I only know the second edition, published about the year 1823. Herts is not in the British Museum series of the first edition, published between 1803 and 1810.

1850.

a11. Ansted, Prof. D. T. On the Absorbent Power of Chalk, and its Water Contents under different Conditions. [Chiefly Herts.] *Proc. Inst. Civ. Eng.* vol. ix, p. 360.

1853.

a12. Chapman, E. J. Mineralogical Notes: —Second Series. 3. Absorption of Water by Chalk. (Watford, Ware, Tring.) *Phil. Mag.* Ser. 4, vol. vi, p. 118.

1863.

a13. South, Sir J. Experiments, made at Watford, on the Vibrations occasioned by Railway Trains passing through a Tunnel. *Proc. Royal Soc.* vol. xiii, No. 59, p. 65.

1870.

a14. Cussans, J. E. History of Hertfordshire. (Geological features, vol. i, Introduction, p. 12.) 3 vols. Folio. Hertford.

1872.

a15. Dean, G. A. The Culture, Management, and Improvement of Landed Estates. (Agricultural Map of Hertfordshire.) 8vo. London.

a16. Evans, J. The Ancient Stone Implements, Weapons, and Ornaments of Great Britain. 8vo. London. [Refers to Geology of Herts, p. 578.]

1873.

a17. Faunthorpe, J. P. The Geography of Hertfordshire, for use in Schools. 8vo. London. (Springs, pp. 11, 12; Mineral Productions, pp. 14, 15.)

a18. Walker, H. Our Field Naturalists' Club. Excursion iv. Over some Old Sea Beds [Glacial and Eocene, Watford]. *Leisure Hour*, p. 446.

XIX.

SOME HERTFORDSHIRE WELL-SECTIONS.

By W. Whitaker, B.A., F.G.S., Assoc. Inst. C.E.

Read at Watford, 19th February, 1885.

Since the publication of the Geological Survey Memoirs that refer to Hertfordshire, many accounts of wells in the county have come into my hands, and I think that such of these as have a geological interest may be acceptable to the Society, including one which has been published elsewhere, but with the description of which I cannot altogether agree.

Forty-one Hertfordshire wells have been noticed in vol. iv. of the Geological Survey Memoirs (pp. 447-456), and sixteen others in the Memoir on Sheet 47 (pp. 82, 83), whilst our members have recorded a few in the Society's 'Transactions.' *

I take the double opportunity of thanking the various engineers and well-sinkers who have given the details that have enabled me to make this record of local facts, and of asking for others.

Of the well-sections now noticed two are of special interest, namely the deep borings which reach the older rocks at Cheshunt and at Ware, as to the latter of which further information is needed, with regard to the Cretaceous beds.

Albury.—Near Patmore Heath. Shaft. Sunk and communicated by Mr. G. Ingold.

		Ft.
[Drift]	Brown clay	5
	Shingly gravel	15
	Rough stones and chalk	9
Chalk	Loose chalk	5
	Chalk with flints	46
		80

Aldenham House.—A mile N.W. of Elstree. Sunk and communicated by Mr. R. B. Paten, of St. Albans. Shaft 155½ feet, the rest bored.

		Ft.	Ins.
[London Clay, 100 feet]	Yellow clay	20	0
	Blue clay	80	0
[Reading Beds 45½ feet]	Coloured [mottled] clay.....	20	0
	Running sand with water	24	0
	Flints	1	6
	To Chalk	145	6
Chalk with flints	....	244	6
		390	0

* See 'Trans. Watford Nat. Hist. Soc.' Vol. I, Part 5, p. 135; Part 6, p. 170; Vol. II, Part 7, p. 245; and 'Trans. Herts Nat. Hist. Soc.' Vol. I, Part 3, p. 143.

BARNET.—Waterworks, 1876. Sunk and communicated by Messrs. T. DOCWRA AND SON. Shaft 171 feet, the rest bored. Water rises to about 155 feet from the surface, and is lowered by pumping to 186 feet.

		Ft.	Ins.
[Surface deposits.]	Ashes and made ground	1	3?
	Yellow clay and gravel	2	0
[London Clay 113¾ feet.]	Yellow clay	2	0
	Yellow and blue clays	5	0
	Yellow clay, with 6-inch bed of claystone [septaria] at top	16	0
	Yellow and blue clays, with 6-inch bed of claystone at top	4	0
	Blue clay, with 5 beds of claystone, from 2 to 10 inches thick	45	6
	Blue clay and dark sand, with a 3-inch bed of claystone at bottom	6	9
	Blue clay	6	0
	Dark sand	6	0
	Blue clay	9	0
[Basement Bed.]	Blue clay and sand, with small vein of shells	5	0
	Dark sand with water	8	0
	Pebbles	0	6
[Reading Beds, 50 feet]	Mottled clay	13	0
	White sand	4	0
	Yellow and green sand	3	6
	Pebbles	2	0
	Red sand	4	0
	Pebbles	2	0
	Spring sand	20	0
	Green flints	1	6
	To Chalk	167	0*
[Chalk, 293½ feet.]	Mild chalk, with an 18-inch layer of hard grey flint	11	6
	Chalk, with 7 layers of flints, from 5 to 12 inches thick	30	5
	Very soft chalk, with very hard flints at bottom	5	7
	Chalk, with 4 layers of flints, from 4 to 9 inches thick	35	8
	Chalk and flints	10	0
	Chalk, with a 10-inch layer of grey flint in the middle	10	4
	Chalk and flints	10	6
	Chalk, chiefly sticky, with a flint layer	13	0
	Soft chalk, with a 30-inch layer of very hard flints near the top, and a thin layer below	8	3
	Chalk, with a 9-inch flint layer at top and bottom	7	6
	Chalk, chiefly soft, with a flint layer	10	6
	Very hard chalk and flints	2	0
	Chalk, with 2 layers of flints in lower part	11	1
	[*Carried over*	333	4

* Given in the drawing as 168. There may therefore be some error in the details.

		Ft.	Ins.
	[*Brought over*	333	4
[Chalk, 293½ feet.]	Hard chalk with few flints	7	0
	Chalk, with 12- and 9-inch layers of hard flints at top and at bottom	3	9
	Chalk and hard flints (12-inch layer at bottom)	7	0
	Hard chalk, with flints at bottom	2	6
	Hard chalk and flints	4	0
	Chalk, with hard flints at bottom	3	10
	Soft chalk, with few flints	4	0
	Hard chalk and flints, with a foot of soft chalk in the middle	6	6
	Soft, and mostly sticky, chalk, with 3 layers of flints, and 2 feet nearly all flints at bottom	18	9
	Dark soft marl	3	0
	Very hard blue stone	1	3
	Soft grey chalk, partly with flints, and with two flint layers in the lower part	13	3
	Very hard flints, with soft veins of chalk	3	4
	Soft chalk, with few flints, a flint layer at top	3	3
	Very hard grey chalk, with few flints	15	0
	Very hard grey chalk, with one flint layer	26	2
	Lighter coloured chalk	4	6
	Total (given as 461½ feet on the drawing)	460	5

Bishop's Stortford.—Local Board Sanitarium, a mile south of the town. Sunk and communicated by Mr. G. Ingold, of Bishop's Stortford. Shaft 15 feet, the rest bored.

		Ft.
Made ground		8
Gravel and sand		2
[London Clay, 12 feet]	Grey and red sandy loam	2
	Yellow sandy loam	6
	Stiff brown clay, with red sand in the bottom foot	4
[Reading Beds, 52 feet]	White marly clay	5
	White sandy clay	3
	Greenish-grey sand	14
	Brown clay	2
	Dark green clay	1
	Brown clay	5
	Bright green loam	1
	Yellow sandy clay	6
	Brown clay	1
	Slate-coloured clay	8
	Dark clay, with green veins and black pebbles	1
	Dark sandy clay, with white veins	4
	Dark green sand	1
	To Chalk	74
Chalk		30
		104

CHESHUNT (Turnford).—New River Company. Sunk and communicated by Messrs. DOCWRA. Over 3,000,000 gallons a day from the Chalk, in which, at a depth of 570 feet, there was a fissure, causing a 34-inch chisel to drop 7 feet.

		Ft.
Gravel		35 ?
London Clay		30 ?
Reading Beds		50
	To Chalk *	115
Chalk	Specimens from 362 to 736 feet. Specimens from 746 to 756 feet are of grey chalk; at 758 feet of nearly white and hard chalk; from 751 to 771 feet of grey clayey chalk	670 ?
[Upper Greensand]	Specimens all much alike; 785 feet, dark grey calcareous sand; 795, 797, lighter grey micaceous sand; 803, 806, 809, the like, but darker; 816, soft grey calcareous sand.†	31 ?
Gault	Specimens of clay from 824 to 980 feet, the last with *Inoceramus* and a small phosphatic nodule. At 980½ feet fragments of *Belemnites* and ? phosphatic nodules (? fallen down, the 980 feet specimen being marked "end of Gault")	164
Devonian.....	Purple shale (? calcareous). The last core 15 feet long and about 15 inches in diameter	30
		1010

ESSENDEN PLACE.—Communicated (to Prof. T. McK. HUGHES) by Baron DIMSDALE.

		Ft.
Gravel and sand		26
Blue [London] Clay		104
Yellow clay [partly London Clay, partly Reading Beds]		40
Layer of flints		
	To Chalk	170
Chalk with flints		170
		340

HADHAM, LITTLE.—The Home Farm. Shaft. Sunk and communicated by Mr. G. INGOLD.

	Ft.
White and blue clay	39
Shingly gravel.....	7
Brown clay	1
Chalk	15
	62

* A note from Messrs. Docwra makes this 102½, and makes the bottom of the Chalk 730ft. This however does not agree with the specimens, and probably does not include the Chalk Marl. Also makes the Gault at 756ft., which is wrong, the specimens showing Chalk Marl.

† Messrs. Docwra's note describes some beds as sandstone, and seems to carry the Upper Greensand to 817½ feet deep.

HADHAM, MUCH.—Green Tye. Public Well, 1879. Sunk and communicated by Mr. G. INGOLD. Shaft 87 feet, bored 2 feet.

		Ft.	Ins.
[Boulder Clay]	White and blue Boulder Clay	54	0
	Hard brown clay.....	2	0
[Gravel and Sand 32½ feet]	Red sandy gravel	18	0
	Red tough sand	2	6
	Yellow sandy fine gravel	5	6
	Red sandy gravel	6	6
Brown clay [? London Clay or Drift]		0	6
		89	0

HATFIELD.—Ponsbourne Park, 1876. Sunk and communicated by Mr. R. B. PATEN. Shaft 10 feet, the rest bored.

		Ft.	In.
[Drift, 20 feet]	Clay and stones [? Boulder Clay]	8	0
	Red sand	2	0
	Gravel	10	0
[London Clay, 140 feet]	Blue clay	106	0
	Sand and clay	34	0
[Reading Beds, 31½ feet]	Light-coloured sand	6	0
	Sand and pebbles	3	6
	Light-coloured sand	11	0
	Sand and pebbles	2	0
	Sand	8	0
	Flints	1	0
	To Chalk	191	6

SAWBRIDGEWORTH (near Harlow, in field 393 of Tithe Map).—Hertfordshire and Essex Waterworks. Communicated by Mr. E. EASTON. Shaft about 75 feet, the rest bored.

		Ft.	Ins.
[Drift, 31½ feet]	Dark brown clay with flints	11	6
	Gravel	1	6
	Dark brown clay with flints	4	0
	Gravel	14	6
[London Clay, 43 feet]	Blue loamy clay	25	0
	Basement Bed. Dark sand with water	3	3
	Basement Bed. Sand and rock	1	3
	Dark sand with water. [This may belong to the basement-bed of the London Clay.].....	13	0
[Reading Beds, ? 62 feet]	Mottled clay	13	0
	Dark sand	9	0
	Yellow loamy sand with small pebbles	6	0
	Green sand with a little water	34	0
	To Chalk	136	0

Some specimens from a trial-bore differ somewhat, as follows:

[Basement Bed of London Clay?]
- At 47 feet, loam with green grains, 2 feet.
- ,, 51¾ feet, brown loam.
- ,, 53 and 62½ feet, brown clayey sand.
- ,, 68, 74, and 79 feet, red mottled, light-coloured and brown mottled clays.
- ,, 91 feet, clayey sand.
- ,, 94, 104, 124 feet, fine buff sand.
- ,, 96 feet, deep red (ferruginous) sand.
- ,, 132 feet, chalk.

An account from Mr. Ingold, well-sinker, of Bishop's Stortford, received later, differs in particulars, and may therefore be given. It is as follows: Iron cylinders 150 feet, the rest bored.

		Ft.	Ins.
Mould		1	0
[Drift, 33½ feet]	Dark brown clay	6	0
	Brown clay	7	4
	Sharp sand	2	0
	Brown clay	0	8
	Blue clay	3	0
	Gravel, the second half-foot a conglomerate	7	0
	Loam	1	0
	Gravel	0	6
	Fine sharp sand	2	0
	Gravel	3	0
[London Clay, 41½ feet]	Dark blue clay	22	6
	Dark sandy clay	5	0
	Hard sand rock	2	6
	Dark sandy clay	11	6
[Reading Beds, 64 feet]	Light-green clay	1	6
	Light-brown clay	2	0
	Light-bluish clay	8	6
	Strong brown clay	3	0
	Black sand	6	0
	Greenish sandy loam	1	0
	Very hard red clay	0	6
	Green sand	1	0
	Yellow sandy loam with black pebbles	5	6
	Greenish-grey sand and sandy loam	29	0
	Dark slate-coloured clay	5	0
	Green-coated flints	1	0
	To Chalk	139	0
Chalk with flints at a depth of 250 feet; with black veins, shells, and nodules of iron-pyrites		111	0
		250	0

Sawbridgeworth.—Chandler's Green. Sunk and communicated by Mr. G. Ingold. Shaft 55½ feet, the rest bored.

	Ft.	Ins.
White and blue Boulder Clay	33	6
Sandy loam	1	6
Gravel, top 10 feet red, the rest yellow and sandy	18	0
Black sandy clay	2	6
Mottled loam	5	0
	60	6

Sawbridgeworth.—North End. Mr. Poole's new house. Shaft. Sunk and communicated by Mr. Ingold.

			Ft.
[Drift]	Brown sand and loam		20
	Boulder Clay	White clay and stones	17
		Blue clay	13
			50

WALTHAM CROSS.—Theobald's Square. Sunk and communicated by Mr. G. INGOLD. Shaft 22 feet, the rest bored. Water, from the Chalk, rose to a height of 13 feet below the surface.

		Ft.	Ins.
Made earth		7	0
[Valley Drift]	Brown clay [brick-earth]	8	0
	Gravel, with much water	11	0
[London Clay, 35 feet]	Black [? dark bluish-grey] clay	32	0
	[Basement-bed] Dark green clay with shells	3	0
[Reading Beds, 61½ feet]	Red and brown clay	4	0
	Black and grey sandy clay	1	6
	Grey sand	18	6
	Light-green sand	3	0
	Greenish-grey sand	8	0
	Green clay	1	0
	Grey sand	8	0
	Black clay	2	0
	Black clay with pebbles	1	6
	Dark sandy clay	14	0
	Layer of green-coated flints		
	To Chalk	122	6
Chalk with flints		53	6
		176	0

WARE.—For the New River Company. J. BARROW, *Proc. S. Wales Inst. Eng.*, vol. xi, no. 7, p. 322, pls. 50, 51; and R. ETHERIDGE, *Pop. Sci. Rev.*, n.s., vol. iii, p. 279. Shaft 34 feet, the rest bored.

		Ft.	Ins.
Surface earth, and gravel and sand		14	0
Chalk	Soft chalk	416	0
	Chalk Marl *	128	0
Upper Greensand *		77	0
Gault		160	0
Lower Greensand [? May be base of Gault]		1	6
Wenlock Shale [with calcareous layers, lenticular ?, and fossiliferous], dipping 40° southwards ?		35	0
		831	6

WARE.—Little Fanhams Hall Farm, on the northern slope of valley, a mile south of Thundridge Church. 1878. About 197 feet above Ordnance Datum. Tube-well. Communicated by Mr. R. G. AUSTIN, of Hertford. Water, from the Chalk, rose to about 72 feet from the surface.

		Ft.	Ins.
? Soil		3	6
[Glacial Drift]	Boulder clay with chalk particles	28	6
	Brown sand, with bad water, which rose to the surface	1	0
	Hard clay and pebbles [? Boulder Clay]	12	6
	Yellow gravel, coarse and loamy	14	6
	To Chalk [*carried over*]	60	0

* Too great a thickness is here given to the Chalk Marl and to the Upper Greensand, under the former of which must be included some of the overlying Lower Chalk, whilst the latter in all likelihood is in great part Chalk Marl.

	Ft.
[*Brought over*	60
Dry clayey chalk and flints (water struck at 90 feet, and rose 18 feet) .... about	30
Chalk and flints .... ,,	22
,,	112

Watford.—London Orphan Asylum. Sunk and communicated by Mr. R. B. Paten. Shaft 51½ feet, the rest bored.

		Ft.	Ins.
[Drift]	Brown clay	12	6
	Gravel	19	6
[? Drift or Reading Beds]	Sand*	18	0
	Flints	1	6
	To Chalk	51	6
Chalk with flints		255	6
		307	0

The following section came to hand whilst this paper was in the press, too late for insertion in its proper position.

Broxbourne.—New River Company. Communicated by Mr. J. Taylor, engineer to the Company.

		Ft.
Soil		2
[Valley gravel] Ballast		8
[Basement-bed of London Clay]	Loamy sand	3
	Black silt.....	5
	Black silt, shelly.....	1
	Black silt†	1
[Reading Beds, 40 feet]	Blue clay	1
	Peat and clay	3
	Running sand	9
	Green sand	6
	Thin veins of dark sand and clay	20½
	Flints	0½
	To Chalk	60
Chalk		70

* If this sand belongs to the Reading Beds (and I know of no such sand in the Drift here), there must be a small outlier, or a large pipe, of the Reading Beds, making, however, no feature at the surface, and therefore not suspected.

† It is hard to make out these sandy and silty beds, but from the occurrence of shells one is led to infer that they belong to the basement-bed of the London Clay.

XX.

METEOROLOGICAL OBSERVATIONS TAKEN AT WANSFORD HOUSE, WATFORD, DURING THE YEAR 1883.

By John Hopkinson, F.L.S., F.G.S., F.R.Met.Soc.

Read at Watford, 24th March, 1885.

In this, the sixth annual report of the results of meteorological observations taken at Wansford House, Watford, I purpose giving a summary, in tabular form, of some of the principal results of observations of the five preceding years, so that we may have a five-year mean with which to compare some of the features of this and perhaps future years; and may also obtain, as far as can be inferred from observations extending over such a limited period, more concise information on the climate of Watford than is furnished by the annual reports.

During this period observations have been taken in accordance with the requirements of the Royal Meteorological Society for its Climatological Stations, and the principal results have been published in that Society's 'Meteorological Record.' The pressure of the atmosphere, and the direction and estimated force of the wind, which I have recorded, are observations not required by the Society from these stations.

Full particulars as to the station, the instruments used, and the method of observation, have been given in previous reports, but as reference to these reports in three different volumes of our 'Transactions'* would have to be made to ascertain these particulars, I will here give a summary of the information on these points contained in those reports.

The longitude of the station is 0° 23′ 40″ W., and the latitude 51° 39′ 45″ N. The position is on a slight slope towards the east, about half way between the highest ground in the neighbourhood and the alluvial plain in the valley of the Colne. The centre of the town of Watford is scarcely half a mile to the south. The ground-level, where the thermometer-screen and rain-gauge are placed, is 223 feet above Ordnance Datum (mean sea-level), which is about the average of Watford. The cistern of the barometer is 234 feet above this datum.

The instruments used are by Mr. J. J. Hicks, of Hatton Garden, London, and (the wind-vane of course excepted) have been verified at the Kew Observatory. The rain-gauge has since been examined by Mr. G. J. Symons, F.R.S., and the barometer and thermometers by Mr. W. Marriott, in the course of his inspection of the Meteorological Society's stations.

The barometer is a standard on Fortin's principle, with a tube half an inch in internal diameter, and requiring a correction of +0·004 inch, of which +0·003 is due to capillarity. The readings

* 'Trans. Watford Nat. Hist. Soc.,' Vol. I, p. 217, and Vol. II, p. 209; and 'Trans. Herts Nat. Hist. Soc.,' Vol. I, p. 121.

are corrected for this index error, reduced to 32° in accordance with the readings of the attached thermometer, and to sea-level.

The thermometers are in a "Stevenson" screen, with their bulbs four feet above the ground over grass. They consist of a dry-bulb, a wet-bulb, a "Rutherford" minimum, and a "Negretti" maximum. The readings are corrected for index errors, which are very slight, being usually *nil*, and in only one case reaching 0°·3.

The rain-gauge is of the "Snowdon" pattern,* five inches in diameter, and with the rim one foot above the ground, and therefore 224 feet above sea-level. The exposure is perfectly open.

The wind-vane, which rotates freely with the slightest breeze, is about 25 feet above the ground, 4 feet above ridge of roof of stable, and 105 feet distant from nearest object of equal height.

All the observations are taken at 9 a.m. and are entered to the same day, except the readings of the maximum thermometer and the rain-gauge, which are entered to the previous day. The adopted mean temperature is the arithmetical mean of the dry-bulb (9 a.m.), minimum, and maximum thermometers. The column in the principal table headed "dryness" expresses the difference between the temperature of the air and that of the dew-point. No secular corrections are applied to any of the readings.

The following table gives the means of some of the principal results of observations taken during the five years 1878-82, for each month and for the year:—

Means of Meteorological Observations taken at Wansford House, Watford, 1878–82.

Months.	Pressure.	Temperature.		Tension of Vapour.	Humidity.	Rainfall.		Cloud 0–10.
		Mean.	Daily Range.			Total.	Days.	
	ins.	°	°	in.	%	ins.		
January.....	30·177	34·1	9·7	·174	88	1·72	12	7·5
February	29·949	39·3	10·4	·212	89	2·95	18	8·0
March	30·024	42·5	15·6	·217	81	1·46	13	6·2
April	29·850	46·0	16·2	·245	78	2·77	16	6·0
May	30·013	52·8	18·3	·300	72	2·34	14	6·1
June	29·918	57·9	16·2	·372	75	3·94	19	7·2
July	29·927	61·1	16·4	·407	75	2·83	17	6·6
August	29·883	60·6	14·2	·425	80	3·66	15	7·4
September	29·967	56·8	16·2	·389	84	2·83	13	6·4
October	29·932	47·6	13·1	·291	88	3·50	17	6·6
November	29·931	41·5	11·7	·229	87	2·69	16	6·2
December	29·927	36·2	10·6	·194	91	2·77	16	7·2
Year	29·958	48·0	14·0	·288	82	33·46	186	6·8

* A "Howard" rain-gauge is used as a check upon the readings of the "Snowdon" taken when I am absent from home.

From this table (substituting, however, for the values for Dec. 1882 those for Dec. 1877), the following summary of the means for the seasons from Dec. 1877 to Nov. 1882, is compiled:—

MEANS FOR THE SEASONS FROM DEC. 1877 TO NOV. 1882, AT WATFORD.

Seasons, 1877–82.	Pressure.	Temperature.		Tension of Vapour.	Humidity.	Rainfall.		Cloud 0–10.
		Mean.	Daily Range.			Total.	Days.	
	ins.	°	°	in.	%	ins.		
Winter	30·044	36·5	10·3	·194	89	6·95	46	7·5
Spring	29·962	47·3	16·7	·254	77	6·57	41	6·1
Summer.....	29·909	59·9	15·6	·402	77	10·23	51	7·1
Autumn.....	29·942	48·4	13·7	·303	86	9·02	47	6·7

The monthly means of the daily observations in 1883, and results deduced from them, are given as usual in the accompanying tables (pp. 184, 185); and from these tables the following summary for the different seasons (the winter including Dec. 1882 from the report for that year) is deduced, results for Greenwich Observatory being added for comparison as usual:—

MEANS FOR THE SEASONS FROM DEC. 1882 TO NOV. 1883, AT WATFORD.

Seasons, 1882–83.	Pressure.	Temperature.		Tension of Vapour.	Humidity.	Rainfall.		Cloud 0–10.
		Mean.	Daily Range.			Total.	Days.	
	ins.	°	°	in.	%	ins.		
Winter	29·886	40·1	10·5	·222	91	10·44	60	7·3
Spring	29·981	45·1	16·4	·232	76	4·19	31	6·0
Summer.....	29·962	60·0	17·8	·381	73	6·29	41	6·9
Autumn.....	29·870	49·5	13·6	·309	87	9·73	55	6·9

THE SAME AT GREENWICH.

Seasons, 1882–83.	Pressure.	Temperature.		Tension of Vapour.	Humidity.	Rainfall.		Cloud 0–10.
		Mean.	Daily Range.			Total.	Days.	
	ins.	°	°	in.	%	ins.		
Winter	29·887	41·3	9·6	·229	89	6·36	50	7·3
Spring	29·963	45·0	18·4	·238	77	4·19	33	6·1
Summer.....	29·945	60·3	20·8	·400	77	4·05	39	6·8
Autumn.....	29·876	50·3	13·7	·317	86	8·25	52	6·4

Results of Meteorological Observations taken at Wansford House, Watford, in 1883.

Months.	Pressure of the Atmosphere.	Temperature of the Air.									Humidity of the Air.		
		9 a.m.	Means of		Adopted Mean.	Mean Daily Range.	Absolute Min. and Max.				Absolute Range.	Dryness.	Tension of Vapour.	Relative Humidity.
			Min.	Max.			Min.	Date.	Max.	Date.				
	ins.	°	°	°	°	°	°		°		°	°	in.	%
January	29·920	39·6	35·9	44·9	40·1	9·0	27·5	31st	54·3	1st	26·8	2·8	·219	90
February	30·087	41·6	35·8	48·3	41·9	12·5	28·0	17th	54·9	24th	26·9	3·0	·234	89
March	29·959	35·5	29·6	42·9	36·0	13·3	20·5	24th	54·5	5th	34·0	4·6	·173	83
April	30·024	47·0	37·6	55·7	46·8	18·1	26·7	9th	65·7	5th	39·0	7·9	·239	74
May	29·959	53·0	43·3	61·2	52·5	17·9	30·8	4th	76·1	24th	45·3	9·4	·284	70
June	29·978	59·7	48·7	68·2	58·9	19·5	39·3	1st	81·5	29th	42·2	8·8	·373	73
July	29·873	59·9	51·3	67·2	59·5	15·9	43·5	16th	81·2	2nd	37·7	8·4	·381	74
August	30·034	61·5	52·6	70·7	61·6	18·1	42·0	20th	79·8	13th	37·8	9·4	·390	71
September	29·839	56·0	49·1	63·6	56·2	14·5	38·2	23rd	75·1	19th	36·9	5·5	·367	82
October	29·990	50·1	44·4	56·5	50·3	12·1	34·0	25th	63·9	14th	29·9	3·7	·316	87
November	29·781	41·6	35·3	49·4	42·1	14·1	25·5	13th	56·7	28th	31·2	2·0	·244	93
December	30·187	39·4	35·8	43·6	39·6	7·8	28·6	7th	53·9	13th	25·3	3·0	·214	89
Year	29·961	48·7	41·6	56·0	48·8	14·4	20·5	Mar. 24	81·5	June 29	61·0	5·7	·286	81

RESULTS OF METEOROLOGICAL OBSERVATIONS TAKEN AT WANSFORD HOUSE, WATFORD, IN 1883—(*continued*).

MONTHS.	RAINFALL.					CLOUD.			WIND.										
	Total Fall.	Max. fall in 24 hours.		No. of days of		Mean Amount 0–10.	No. of days of		Mean Force 0–12.	Number of days of									
	Ins.	Ins.	Date.	Rain or Snow.	Snow only.		Clear Sky.	Overcast.		N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Calm.
January	2·77	·68	15th	21	1	7·1	8	20	1·5	1	4	9	3	5	5	2	2	0
February	4·07	·66	2nd	17	0	7·3	4	14	1·6	0	0	0	6	6	8	6	2	0
March	1·00	·36	19th	11	6	5·3	7	9	1·9	9	7	4	1	2	2	1	4	1
April	1·36	·46	18th	9	1	6·3	5	12	1·6	2	10	3	5	2	2	1	5	0
May	1·83	·63	11th	11	0	6·5	6	7	1·6	2	7	3	2	1	9	2	4	1
June	1·91	·40	15th	13	0	5·9	2	6	1·7	3	7	3	6	3	3	0	5	0
July	3·36	·64	21st	17	0	7·8	0	9	1·7	1	3	0	4	3	5	6	8	1
August	1·02	·45	8th	11	0	6·9	6	8	1·5	1	1	3	1	3	10	6	5	1
September	3·57	·78	29th	17	0	7·0	5	13	2·0	5	2	2	4	1	10	2	1	3
October	2·27	·56	14th	17	0	7·3	3	13	1·3	4	3	0	2	1	8	5	4	4
November	3·89	·52	22nd	21	2	6·4	6	12	1·7	3	1	1	2	5	9	4	4	1
December	1·22	·44	10th	18	3	8·1	3	17	1·8	5	2	2	0	0	5	7	8	2
Year	28·27	·78	Sept. 29	183	13	6·8	56	140	1·6	36	47	30	36	32	76	42	52	14

There is no strongly-marked feature in the weather of the year 1883, taken as a whole. Although the rainfall was less than in any one of the previous eight years, it was still above the average of a long period, and the number of days on which rain fell was also high. The temperature was slightly above the average; its extreme range was less even than in 1882, owing to no low minimum having been recorded, the lowest being only 11°·5 below freezing point, and no very high maximum; but the mean range was a little in excess of the average. The mean pressure of the atmosphere was about the average; there were a few exceptionally high and some rather low pressures, the range being from 28·968 to 30·860 inches.

Difference in 1883 from means of 1878–82, at Watford.

Months.	Pressure.	Temperature.		Tension of Vapour.	Humidity.	Rainfall.		Cloud 0–10.
		Mean.	Daily Range.			Total.	Days.	
January.....	—·257	+6·0	—0·7	+·045	+2	+1·05	+9	—0·4
February	+·138	+2·6	+2·1	+·022	=	+1·12	—1	—0·7
March	—·065	—6·5	—2·3	—·044	+2	—0·46	—2	—0·9
April	+·124	+0·8	+1·9	—·006	—4	—1·41	—7	+0·3
May	—·054	—0·3	—0·4	—·016	—2	—0·51	—3	+0·4
June	+·060	+1·0	+3·3	+·001	—2	—2·03	—6	—1·3
July	—·054	—1·6	—0·5	—·026	—1	+0·53	=	+1·2
August	+·151	+1·0	+3·9	—·035	—9	—2·64	—4	—0·5
September	—·128	—0·6	—1·7	—·022	—2	+0·74	+4	+0·6
October	+·058	+2·7	—1·0	+·025	—1	—1·23	=	+0·7
November	—·150	+0·6	+2·4	+·015	+6	+1·20	+5	+0·2
December	+·260	+3·4	—2·8	+·020	—2	—1·55	+2	+0·9
Year ...	+·003	+0·8	+0·4	—·002	—1	—5·19	—3	=

Compared with the previous year, in 1883 the mean temperature was 0°·2 lower, the mean daily range 0°·2 greater, the relative humidity 3 per cent. less, and the rainfall more than 5 inches less. Rain (or snow) fell on 16 days less in 1883 than in 1882, and snow (only) on 3 days more. The sky was more frequently clear of cloud and less completely overcast, though the mean amount of cloud was the same in both years. The estimated force of the wind was less than in 1882. The smaller rainfall in 1883, and the absence of such a great preponderance of S.W winds as there was in 1882, seem to be the chief features of divergence in the weather of the two years.

In the winter of 1882-83 (Dec. to Feb.) the mean pressure of the atmosphere was below the average, the mean temperature was unusually high, the relative humidity was considerable, and the rainfall was very heavy. In the spring (March to May) the mean pressure was about the average, the mean temperature was unusually low, being only 5° higher than in the winter, the relative humidity was about the average, and the rainfall was below it, and

(as in 1882) less than in any other season of the year. In the summer (June to August) the mean pressure was rather high, the mean temperature was about the average, and the relative humidity and rainfall were considerably below it. In the autumn (Sept. to Nov.) the mean pressure was again high, and the mean temperature, relative humidity, and rainfall were slightly above the average.

DIFFERENCE IN 1882-83 FROM MEANS OF 1877-82, AT WATFORD.

Seasons, 1882-83.	Pressure.	Temperature.		Tension of Vapour.	Humidity.	Rainfall.		Cloud 0-10.
		Mean.	Daily Range.			Total.	Days.	
	ins.	°	°	in.	%	ins.		
Winter	—·158	+3·6	+0·2	+·028	+ 2	+3·49	+14	—·2
Spring	+·019	—2·2	—0·3	—·022	— 1	—2·38	—10	—·1
Summer.....	+·053	+0·1	+2·2	—·021	— 4	—3·94	—10	—·2
Autumn.....	+·072	+1·1	—0·1	+·003	+ 1	+0·71	+ 8	+·2

The following notes record the general character of the weather in each month, and its principal changes.

JANUARY.—Very mild, with a rather humid atmosphere of low pressure, and a considerable amount of rain; the fourth mild month in succession. The first day was very warm (min. 46°·1, max. 54°·1, mean 51°·5), corresponding very closely with the last six days of December 1882. The next four also were warm, the first five being considerably warmer than any similar period during the rest of the month.

1st to 5th	9 a.m.	46°·1	Mean Min.	42°·5	Mean Max.	48°·3	Mean	45°·6
Mean of Month	,,	39 ·6	,,	35 ·9	,,	44 ·9	,,	40 ·1
Difference	,,	6 ·5	,,	6 ·6	,,	3 ·4	,,	5 ·5

The only cold days, with the 9 a.m. temperature below 32°, were the 23rd (mean 32°·8), and the 31st (mean 31°·8). Max. above 42° on 22 days (a very large number for January); min. below 32° on 6 days (a very small number). The last six days were very stormy, and there was a slight fall of snow on the 30th, the only one during the month. This stormy period was ushered in by a rapid decrease in pressure, as shown by the following barometer-readings (at 9 a.m.):—23rd, 30·684; 24th, 30·331; 25th, 29·650; and 26th, 29·188 ins.

FEBRUARY.—Mild, rather bright, with an atmosphere of average humidity and somewhat high pressure, and with much rain, of which more than 4 inches of the amount recorded fell within the first fortnight, and about 4½ ins. by the 18th. The max. fall of the 2nd was nearly equalled on the 10th, and in the five days, from 6th to 10th, about 2 ins. fell. After the 20th there were, on the other hand, seven days in succession (21st to 27th) without rain, and the high mean pressure of the month is due to this period,

the mean for the first fortnight being 29·675 ins. and for the second fortnight, 30·500 ins. The following are the readings of the barometer for the last six days :—

	ins.		ins.		ins.
23rd	30·860	25th.....	30·711	27th.....	30·499
24th	30·709	26th.....	30·681	28th.....	30·517

On the 2nd the low pressure of 28·968 ins. was registered. Max. temp. above 52° on 5 days, never below 42°; min. below 32° on 2 only (1st and 17th).

March.—Very cold, bright, and windy, with a rather humid atmosphere of average pressure, and a great prevalence of strong N. and N.E. winds, accompanied by snow between the 6th and 13th. March is usually a dry month, so that the small amount of rain which fell is not exceptional. Max. temp. above 52° on 2 days only (in 1882 the number of days was 21); min. below 32° on 23 days. Readings below 26° were recorded on eight days.

8th	25°·0	10th.....	22°·9	24th.....	20°·5	28th.....	25°·1
9th	24 ·9	16th.....	22 ·3	27th.....	24 ·5	29th.....	25 ·9

The only tolerably warm periods were the first three and the last three days, a decided and permanent change to warmer weather taking place in the interval between the minimum of 25°·9 on the night of the 28th, and 9 a.m. on 29th, when the temperature had risen to 41°·8.

1st to 3rd.....	9 a.m.	42°·1	Mean Min.	38°·3	Mean Max.	47°·6	Mean 42°·7
Mean of Month	,,	35 ·7	,,	29 ·6	,,	42 ·8	,, 36 ·0
29th to 31st.....	,,	44 ·0	,,	32 ·4	,,	51 ·1	,, 42 ·5

The period of very high pressure of the atmosphere which commenced in February continued into March, the readings of the barometer for the first six days being as follows :—

	ins.		ins.		ins.
1st	30·441	3rd.....	30·711	5th.....	30·639
2nd	30·648	4th.....	30·720	6th.....	30·230

April.—Of average temperature, with a very dry atmosphere of rather high pressure. The month may be divided into a dry and a wet period, no rain falling during the first 17 days (a very long period without), and there being only four days without rain during the last 13. The dry period, after one cold day, the 1st (mean 43°·5), was warm and then turned cold; and the wet period, after one warm day, the 18th (mean 54°·2), was cold and then turned warm, and the temp. throughout was very variable. Max. above 52° on 23 days, above 62° on 3 (3rd, 5th, and 18th); min. below 32° on 6 (1st, 2nd, 9th, 11th, 24th, and 26th). There was a snow-storm, with hail and rain, on the 23rd.

May.—Of average temperature, with a rather dry atmosphere of average pressure. The first half of the month, however, was decidedly cold and wet, and the second half just the reverse. The average temperature from 1st to 14th was 47°, and rain fell, to the amount of 1·38 in., every day but four; and the average temp. from 15th to 31st was 57°, rain falling on one day only, 26th, to

the amount of 0·45 in. Max. temp. above 62° on 14 days, above 72° on 4 (16th, 23rd, 24th, and 25th); min. below 42° on 9, below 32° on 1 (4th).

JUNE.—Of nearly average, but very variable, temperature of considerable daily range, with a rather dry atmosphere of average pressure, and less than the average rainfall. The first half of the month was very dry (a continuation of the dry period which commenced on 15th May); the second half was very wet. From 1st to 14th rain fell on one day only (7th), and then the smallest measurable quantity (0·01 in.), so that there were *practically* 14 days without rain; from 14th to 30th rain fell on every day but four, to the amount of 1·90 in. The temperature was very changeable, warm during the dry period with two cold days (7th and 11th), and cold and very variable during the wet period, the mean temperature being

1st-6th	59°·2	11th	50°·8	24th-25th	64°·0
7th	51 ·2	12th-14th	61 ·7	26th-27th	57 ·6
8th-10th	58 ·2	15th-23rd	55 ·3	28th-30th	67 ·5

Max. above 62° on 25 days, above 72° on 10; min. below 52° on 23, below 42° on 3. There was a thunderstorm on night of 28th-29th with 0·25 in. of rain.

JULY.—Cold and very gloomy, with a considerable amount of rain, and an atmosphere of low pressure and average humidity. The first 13 days were warm, with the exception of two rather cool days, 4th (mean 59°·4) and 12th (mean 59°·6); the next 14 days were very cold for July, and two, 16th (mean 53°·5) and 23rd (mean 54°·3) especially so; and the last 4 days were rather warmer.

1st to 13th	9 a.m.	63°·3	Mean Min.	54°·9	Mean Max.	71°·2	Mean	63°·1
14th to 27th	,,	56 ·9	,,	48 ·6	,,	63 ·3	,,	56 ·3
28th to 31st	,,	60 ·1	,,	51 ·0	,,	69 ·9	,,	60 ·3

Max. temp. above 72° on 5 days; min. below 52° on 17. There were several thunderstorms—on night of 2nd-3rd with 0·26 in. rain, on afternoon of 14th with 0·55 in., and on afternoon of 21st with 0·64 in. accompanied by large hailstones. Thunder was also heard on the 15th and 31st.

AUGUST.—Rather warm, with a considerable mean daily range of temperature, a very dry atmosphere of high pressure, and a very small rainfall. The latter part of the month was warmer than the earlier, the change taking place on the evening or night of the 17th. The highest maximum, 79°·8, was, however, during the colder period, on the day after a low minimum, 44°·0; and the lowest minimum, 42°·0, was during the warmer period, on the day before a high maximum, 78°·9; the range in the two consecutive days, in each instance, thus being about 36°. Max. temp. above 72° on 13 days (all after 12th); min. below 52° on 13. The maximum fall of rain, 0·45 in. on 8th, was the result of a thunderstorm, and the only other fall exceeding 0·10 in. was 0·20 on 31st.

SEPTEMBER.—Rather cold and very wet, with an atmosphere of average humidity and low pressure. The only decidedly warm

period was from 12th to 19th, with the mean 60°·7, being 4°·5 above that of the month, and the mean max. 71°·2, being 7°·6 above that of the month. Max. temp. above 62° on 21 days, above 72° on 3 (17th-19th); min. below 42° on 2 (6th and 9th). From 1st to 11th there were only three days without rain (3rd, 6th, and 9th), none fell between 12th and 19th, the warm period, and from 20th to the end of the month there were only two days without, 21st and 22nd. On the day of max. fall, and the following day, pressure was very low, being 29·280 ins. on 29th and 29·329 ins. on 30th. The first week and the last week in the month were very windy. On the 17th there was a violent thunderstorm with heavy rain in the north of London. At Watford, however, the sky was cloudless and the atmosphere calm, and no rain whatever fell during the day.

October.—Warm, with a rather dry atmosphere of average pressure, and with less than the average rainfall. There was no decided change in temperature, but there were two periods of seven days each—1st to 7th, and 18th to 24th—with the temperature not above the average. Max. above 52° on 25 days, above 62° on 5; min. below 42° on 8, never below 32°. The first 5 days were wet, the next 8 without any rain, more than an inch fell on 14th and 15th together, and the weather became gradually drier and at the same time duller and calmer for the last fortnight.

November.—Rather mild, very wet, and with a humid atmosphere of rather low pressure. There was one cold period, 10th to 17th, and one rather cold day during the warm period (23rd, mean 38°·1).

1st to 9th	9 a.m.	44°·3	Mean Min.	32°·1	Mean Max.	51°·7	Mean	42°·7
10th to 17th.....	,,	36 ·9	,,	29 ·9	,,	45 ·8	,,	37 ·5
18th to 30th.....	,,	43 ·4	,,	36 ·8	,,	50 ·7	,,	43 ·6

Max. above 52° on 7 days; min. below 32° on 8 (7th, 12th to 17th, and 27th). Rain fell every day from 4th to 10th, and every day but one (16th) from 14th to 25th. About an inch fell on the 4th and 5th together, and over an inch and a half from 23rd to 25th. There was a slight fall of snow on 14th, and a very heavy fall on 22nd.

December.—Very mild, dry, and dull, with a dry atmosphere of very high pressure. The only really cold days were the 7th and 8th (mean 32°·8), and there were two very warm days, the 13th and 14th (mean 49°·5), followed by a very decided fall in temperature. Max. above 42° on 17 days, above 52° on 3; min. below 32° on 5, all before 10th but one (24th). Rain fell every day from 9th to 17th, and 25th to 29th; and snow on 5th, 6th, and 16th, and also, but too slight to measure, on 7th. There was a gale of wind on the night of 11th-12th, and the weather was generally stormy from 10th to 19th, and comparatively calm for the remainder of the month, with dense fogs for four days in succession, 24th to 27th.

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XXI.

REPORT ON PHENOLOGICAL PHENOMENA OBSERVED IN HERTFORDSHIRE DURING THE YEAR 1883.

By John Hopkinson, F.L.S., F.G.S., etc.

Read at Watford, 24th March, 1885.

Phenological Phenomena have now been observed in Hertfordshire for eight years in succession. For the first five years there was an increase each year in the number of observers; for the last three there has each year been a slight decrease, and our principal table showing the dates of flowering of plants in 1883 comprises returns from only eight stations as against nine in 1882 and ten in 1881. We have no longer returns for St. Albans from Mr. A. E. Gibbs, nor for Hoddesdon from Miss Alice Warner, but we have a new station, Hitchin, where observations have been made by the Hitchin Natural History Club, and have been communicated to the Society by Mr. William Hill, jun.

Our present phenological stations, for which returns are entered in the accompanying table, with the names of the observers, are as follows:—

Watford	Mrs. J. Hopkinson.	High Wych	Miss Simpson.
Harpenden	J. J. Willis.	Hitchin	Nat. Hist. Club.
Hertford	R. T. Andrews.	Odsey	H. G. Fordham.
Ware (Fanhams)	R. B. Croft.	Royston	A. Kingston.

In 1883 the Meteorological Society issued a new and extended list of species to be observed, the number of plants being increased from 71 to 79, of insects from 8 to 11, and of birds from 17 to 21, so that, including the frog as before, the total number of species to be observed is raised from 97 to 112. Of the plants, the hairy bittercress (*Cardamine hirsuta*), barren strawberry (*Potentilla fragariastrum*), cow-chervil (*Anthriscus sylvestris*), field gentian (*Gentiana campestris*), and ivy-leaved speedwell (*Veronica hederifolia*), are omitted in the new list, and the following are added:—water-cress (*Nasturtium officinale*), garlic hedge-mustard (*Sisymbrium Alliaria*), spindle-tree (*Euonymus europæus*), sycamore (*Acer Pseudo-platanus*), horse-chestnut (*Æsculus Hippocastanum*), laburnum (*Cytisus Laburnum*), mountain ash (*Pyrus Aucuparia*), hawthorn (*Cratægus Oxyacantha*), wild carrot (*Daucus Carota*), dogwood (*Cornus sanguinea*), lilac (*Syringa vulgaris*), privet (*Ligustrum vulgare*), and beech (*Fagus sylvatica*). Of the insects, the winter gnat (*Trichocera hiemalis*) is omitted, and the bloody-nosed beetle (*Timarcha lævigata*), glow-worm (*Lampyris noctiluca*), wasp (*Vespa vulgaris*), and orange-tipped butterfly (*Anthocaris cardamines*), are added. Of the birds, all in the former list are included, and there are added the house-martin (*Hirundo urbica*), sand-martin (*H. riparia*), goat-sucker or nightjar (*Caprimulgus europæus*), and corncrake (*Crex pratensis*).

As observations of the insects and birds are reported upon by other recorders, the alterations in the list of these need not be here further referred to. Of the plants, one of the species omitted (*Gentiana campestris*) is generally of somewhat rare occurrence, and the date of its flowering has hitherto but seldom been observed, and the others are species which come into flower very irregularly and are dependent for their state of forwardness more upon situation than differences in the seasons. Most of the species added are trees or shrubs.

In the following table, recording observations on insects and birds, etc., the earliest dates are as before alone given. For details Mr. Silvester's notes on the insects observed (p. 91), and Mr. Littleboy's notes on the birds (p. 82), should be referred to.

Earliest Dates of Observations of Insects, Birds, etc., in 1883, with the Mean Date for 1876–83.

No.	Species.	1883.	Mean.
80.	*Melolontha vulgaris* (cock-chafer) appears	May 14	May 24
81.	*Rhizotrogus solstitialis* (fern-chafer) ap.	June 29	June 17
82.	*Timarcha lævigata* (bloody-nosed beetle) ap.	.....	.....
83.	*Lampyris noctiluca* (glow-worm) ap.	June 17	.....
84.	*Apis mellifica* (honey-bee) ap.	Jan. 1	Jan. 27
85.	*Vespa vulgaris* (common wasp) ap.	Apl. 2	.....
86.	*Pieris Brassicæ* (large white butterfly) ap.	Apl. 5	Apl. 13
87.	*P. Rapæ* (small white butterfly) ap.	Apl. 1	Mar. 27
88.	*Anthocharis cardamines* (orange-tip butterfly) ap.	May 5	.....
89.	*Epinephile Janira* (meadow-brown butterfly) ap.	May 16	May 24
90.	*Bibio Marci* (St. Mark's-fly) ap.	Apl. 18	Apl. 28
91.	*Strix Aluco* (brown owl) hoots	.....	Aug. 7
92.	*Muscicapa grisola* (spotted flycatcher) arrives	Apl. 25	May 16
93.	*Turdus musicus* (song-thrush) sings	Jan. 1	Jan. 12
94.	*T. pilaris* (fieldfare) arrives	Oct. 25	Nov. 4
95.	*Daulias Luscinia* (nightingale) sings	Apl. 14	Apl. 14
96.	*Saxicola Œnanthe* (wheatear) returns	Sept. 27	.....
97.	*Phylloscopus Trochilus* (willow-wren) sings	Apl. 4	Mar. 29
98.	*P. collybita* (chiff-chaff) sings	Apl. 4	Mar. 22
99.	*Alauda arvensis* (sky-lark) sings	Jan. 4	Jan. 17
100.	*Fringilla cœlebs* (chaffinch) sings	Feb. 9	Feb. 4
	——— nests	May 30	.....
101.	*Corvus frugilegus* (rook) builds	Feb. 20	Feb. 20
102.	*Cuculus canorus* (cuckoo) calls	Apl. 14	Apl. 11
103.	*Hirundo rustica* (swallow) arrives	Apl. 1	Apl. 12
104.	*H. urbica* (house-martin) arr.	Apl. 14	.....
105.	*H. riparia* (sand-martin) arr.	Apl. 18	.....
106.	*Cypselus Apus* (swift) arrives	May 1	May 8
107.	*Caprimulgus europæus* (goatsucker) arr.	.....	.....
108.	*Columba Turtur* (turtle-dove) coos	Apl. 20	May 1
109.	*Perdix cinerea* (partridge) pairs	Jan. 30	.....
	——— hatches	June 15	June 18
110.	*Scolopax Rusticola* (woodcock) arrives	Oct. 16	Oct. 23
111.	*Crex pratensis* (corn-crake) arr.	May 3	.....
112.	*Rana temporaria* (common frog) spawns	Mar. 4	Mar. 13

Dates of Flowering of Plants observed in 1883, with the Mean Date for 1876–83.

No.	Species.	Watford.	Harpenden.	Hertford.	Ware.	High Wych.	Hitchin.	Odsey.	Royston.	Mean.
1.	*Anemone nemorosa*	Mar. 18	Mar. 3	Mar. 5	Mar. 28	.....	Apl. 1	.....	.....	Mar. 12
2.	*Ranunculus Ficaria*	Feb. 4	Feb. 25	.....	Feb. 22	Feb. 23	.....	.....	Feb. 26	Feb. 19
3.	*Ranunculus acris*	Apl. 27	May 10	Apl. 20	May 12	May 18	Apl. 24	.....	May 14	Apl. 23
4.	*Caltha palustris*	Apl. 1	Mar. 15	Apl. 12	Apl. 9	.....	.....	.....	Apl. 10	Mar. 20
5.	*Papaver Rhœas*	May 30	June 6	June 5	.....	.....	.....	.....	May 30	May 29
6.	*Nasturtium officinale*	.....	June 16	.....	.....	.....	.....	.....	.....	.....
7.	*Cardamine pratensis*	Apl. 27	Apl. 20	Apl. 24	Apl. 18	.....	Apl. 25	.....	Apl. 27	Apl. 12
8.	*Sisymbrium Alliaria*	Apl. 14	May 14	.....	.....	.....	.....	.....	.....	.....
9.	*Draba verna*	.....	Feb. 15	Mar. 3	.....	.....	.....	.....	Mar. 30	Mar. 6
10.	*Viola odorata*	.....	Jan. 12	.....	.....	Feb. 9	.....	Feb. 24	Jan. 14	Feb. 12
11.	*Polygala vulgaris*	June 2	June 7	.....	.....	.....	May 17	.....	May 15	May 5
12.	*Lychnis Flos-cuculi*	May 27	June 4	May 31	.....	May 29	May 17	.....	.....	May 25
13.	*Stellaria Holostea*	Apl. 11	Apr. 15	Apl. 7	Apl. 11	.....	.....	.....	Apl. 25	Apl. 5
14.	*Malva sylvestris*	June 30	June 7	June 7	.....	June 6	June 13	June 17	June 9	June 5
15.	*Hypericum tetrapterum*	.....	.....	June 28	.....	.....	July 14	.....	.....	July 3
16.	*Hypericum pulchrum*	June 26	June 29	June 24	.....	.....	.....	.....	June 29	June 29
17.	*Geranium Robertianum*	May 19	May 21	.....	May 15	May 15	May 15	.....	May 13	Apl. 29
18.	*Euonymus europœus*	June 4	.....	.....	.....	.....	.....	.....	.....	.....
19.	*Acer Pseudo-platanus*	.....	.....	.....	.....	.....	.....	.....	.....	.....
20.	*Æsculus Hippocastanum*	.....	May 19	.....	.....	May 27	.....	.....	.....	.....
21.	*Cytisus Laburnum*	May 19	May 21	.....	.....	.....	.....	.....	.....	.....
22.	*Trifolium repens*	May 27	May 31	.....	.....	May 29	May 24	May 29	May 24	May 18
23.	*Lotus corniculatus*	May 31	June 7	June 13	.....	May 27	May 17	.....	May 23	May 20
24.	*Vicia Cracca*	.....	.....	June 14	.....	June 26	June 15	.....	June 30	June 25
25.	*Vicia sepium*	Apl. 30	Apl. 24	May 1	May 17	May 22	.....	.....	May 15	Apl. 28
26.	*Lathyrus pratensis*	June 4	June 11	June 15	.....	June 8	June 14	.....	June 9	June 4
27.	*Prunus spinosa*	Apl. 8	Apl. 11	Apl. 9	Apl. 8	.....	Apl. 4	Apl. 8	Apl. 14	Mar. 23
28.	*Spiræa Ulmaria*	.....	June 7	June 1	.....	June 21	June 17	.....	June 24	June 14
29.	*Potentilla anserina*	May 26	June 3	May 26	May 21	May 20	May 13	May 15	May 21	May 15
30.	*Rosa canina*	June 2	June 5	June 6	.....	June 3	June 1	June 2	June 3	June 3
31.	*Pyrus Aucuparia*	.....	May 24	.....	.....	.....	.....	.....	.....	.....
32.	*Cratægus Oxyacantha*	May 20	May 18	.....	.....	May 19	.....	.....	.....	.....
33.	*Epilobium hirsutum*	July 8	July 10	July 7	.....	July 6	July 8	.....	July 12	July 8
34.	*Epilobium montanum*	June 17	June 15	June 17	.....	June 18	.....	.....	.....	June 10
35.	*Angelica sylvestris*	.....	.....	Aug. 1	.....	.....	.....	.....	.....	July 29
36.	*Daucus Carota*	.....	.....	.....	.....	.....	.....	.....	July 5	.....
37.	*Hedera Helix*	Sept. 23	.....	.....	.....	.....	.....	.....	.....	Sept. 27

40.	*Galium Aparine*	May 27	May 25	May 20	May 19	May 17	May 13	May 14	May 23	May 15
41.	*Galium verum*	July 1	June 25	June 19	.....	July 5	July 8	July 5	July 4	June 30
42.	*Dipsacus sylvestris*	.....	.....	Aug. 1	.....	Sept. 27	.....	.....	July 28	July 24
43.	*Scabiosa succisa*	.....	.....	Aug. 1	.....	.....	.....	.....	.....	July 24
44.	*Petasites vulgaris*	.....	.....	Mar. 31	.....	.....	.....	.....	.....	Mar. 18
45.	*Tussilago Farfara*	Feb. 25	Feb. 28	Feb. 16	Feb. 22	.....	.....	Feb. 22	.....	Feb. 24
46.	*Achillea Millefolium*	June 24	June 15	July 1	.....	.....	.....	.....	July 2	June 23
47.	*Chrysanthemum Leucanthemum*	May 26	May 25	May 21	May 31	May 28	May 20	.....	.....	May 18
48.	*Artemisia vulgaris*	.....	.....	.....	.....	Sept. 7	Aug. 16	.....	July 31	Aug. 3
49.	*Senecio Jacobæa*	July 1	June 20	July 1	.....	July 12	July 25	July 7	.....	June 29
50.	*Centaurea nigra*	.....	June 28	July 1	.....	.....	June 14	.....	.....	June 20
51.	*Carduus lanceolatus*	.....	June 21	June 22	.....	July 26	June 20	.....	.....	June 17
52.	*Carduus arvensis*	June 2	July 8	May 31	.....	July 4	.....	.....	.....	June 17
53.	*Sonchus arvensis*	July 8	July 9	July 10	.....	.....	July 22	.....	July 7	July 9
54.	*Hieracium Pilosella*	.....	May 22	May 4	.....	June 5	.....	.....	.....	May 15
55.	*Campanula rotundifolia*	.....	July 9	July 3	.....	.....	July 7	July 8	July 14	July 8
56.	*Ligustrum vulgare*	.....	June 25	.....	.....	June 18	.....	.....	.....	.....
57.	*Convolvulus sepium*	.....	.....	June 30	.....	June 29	July 17	.....	July 9	July 11
58.	*Symphytum officinale*	.....	May 28	May 24	May 12	May 20	.....	.....	.....	May 6
59.	*Pedicularis sylvatica*	.....	.....	June 1	.....	.....	.....	.....	.....	May 12
60.	*Veronica Chamædrys*	Apl. 28	Apl. 23	Apl. 23	May 15	.....	Apl. 17	.....	.....	Apl. 21
61.	*Mentha aquatica*	.....	.....	Aug. 1	.....	.....	.....	.....	.....	July 31
62.	*Thymus Serpyllum*	.....	June 30	June 7	.....	.....	.....	.....	.....	June 8
63.	*Prunella vulgaris*	June 30	June 29	June 21	.....	.....	.....	.....	.....	June 18
64.	*Nepeta Glechoma*	Mar. 18	Mar. 17	Mar. 23	.....	Mar. 29	.....	Apl. 3	.....	Mar. 25
65.	*Galeopsis Tetrahit*	.....	.....	June 13	.....	.....	June 17	.....	.....	June 27
66.	*Stachys sylvatica*	June 9	June 13	June 12	.....	June 6	.....	.....	.....	June 6
67.	*Ajuga reptans*	May 19	May 17	.....	.....	May 20	.....	.....	May 12	May 3
68.	*Primula veris*	Apl. 8	Apl. 1	Mar. 26	Mar. 26	Mar. 30	Apl. 7	Apl. 5	Apl. 6	Mar. 18
69.	*Plantago lanceolata*	Apl. 28	Apl. 26	Apl. 24	May 6	.....	Apl. 30	.....	May 6	Apl. 21
70.	*Mercurialis perennis*	Feb. 2	Jan. 22	Feb. 4	Jan. 16	.....	.....	.....	.....	Feb. 15
71.	*Ulmus montana*	.....	Feb. 23	Feb. 26	.....	.....	.....	Feb. 26	Mar. 14	Mar. 1
72.	*Salix Caprea*	Mar. 14	Mar. 5	Mar. 8	Mar. 14	.....	Apl. 7	Mar. 4	Mar. 15	Mar. 6
73.	*Fagus sylvatica*	.....	.....	.....	.....	.....	.....	.....	.....	.....
74.	*Corylus Avellana*	Jan. 27	Feb. 14	Jan. 4	Jan. 5	.....	.....	Jan. 21	Feb. 8	Jan. 27
75.	*Orchis maculata*	June 2	June 11	June 11	.....	.....	June 3	.....	June 7	June 4
76.	*Iris Pseud-acorus*	June 3	June 6	June 7	.....	June 12	June 16	.....	June 6	June 3
77.	*Narcissus Pseudo-narcissus*	.....	Mar. 18	Mar. 5	Mar. 1	.....	.....	Mar. 4	.....	Mar. 4
78.	*Galanthus nivalis*	Jan. 20	Jan. 20	Jan. 14	.....	Jan. 17	.....	Jan. 20	Jan. 22	Jan. 21
79.	*Scilla nutans*	Apl. 21	Apl. 12	Apl. 18	May 7	.....	Apl. 17	.....	Apl. 26	Apl. 14

Dates of Flowering of Plants observed in 1883, with the Mean Date for 1876–83.

No.	Species.	Watford.	Harpenden.	Hertford.	Ware.	High Wych.	Hitchin.	Odsey.	Royston.	Mean.
1.	*Anemone nemorosa*	Mar. 18	Mar. 3	Mar. 5	Mar. 28	.....	Apl. 1	.....	.....	Mar. 12
2.	*Ranunculus Ficaria*	Feb. 4	Feb. 25	.....	Feb. 22	Feb. 23	.....	.....	Feb. 26	Feb. 19
3.	*Ranunculus acris*	Apl. 27	May 10	Apl. 20	May 12	May 18	Apl. 24	.....	May 14	Apl. 23
4.	*Caltha palustris*	Apl. 1	Mar. 15	Apl. 12	Apl. 9	.....	.....	.....	Apl. 10	Mar. 20
5.	*Papaver Rhœas*	May 30	June 6	June 5	.....	.....	.....	.....	May 30	May 29
6.	*Nasturtium officinale*	.....	June 16	.....	.....	.....	.....	.....	.....	.....
7.	*Cardamine pratensis*	Apl. 27	Apl. 20	Apl. 24	Apl. 18	.....	Apl. 25	.....	Apl. 27	Apl. 12
8.	*Sisymbrium Alliaria*	Apl. 14	May 14	.....	.....	.....	.....	.....	.....	.....
9.	*Draba verna*	.....	Feb. 15	Mar. 3	.....	.....	.....	.....	Mar. 30	Mar. 6
10.	*Viola odorata*	.....	Jan. 12	.....	.....	Feb. 9	.....	Feb. 24	Jan. 14	Feb. 12
11.	*Polygala vulgaris*	Juue 2	June 7	.....	.....	.....	May 17	.....	May 15	May 5
12.	*Lychnis Flos-cuculi*	May 27	June 4	May 31	.....	May 29	May 17	.....	.....	May 25
13.	*Stellaria Holostea*	Apl. 11	Apr. 15	Apl. 7	Apl. 11	.....	.....	.....	Apl. 25	Apl. 5
14.	*Malva sylvestris*	June 30	June 7	June 7	.....	June 6	June 13	June 17	June 9	June 5
15.	*Hypericum tetrapterum*	.....	.....	June 28	.....	.....	July 14	.....	.....	July 3
16.	*Hypericum pulchrum*	June 26	June 29	June 24	.....	.....	.....	.....	June 29	June 29
17.	*Geranium Robertianum*	May 19	May 21	.....	May 15	May 15	May 15	.....	May 13	Apl. 29
18.	*Euonymus europæus*	June 4	.....	.....	.....	.....	.....	.....	.....	.....
19.	*Acer Pseudo-platanus*	.....	.....	.....	.....	.....	.....	.....	.....	.....
20.	*Æsculus Hippocastanum*	.....	May 19	.....	.....	May 27	.....	.....	.....	.....
21.	*Cytisus Laburnum*	May 19	May 21	.....	.....	.....	.....	.....	.....	.....
22.	*Trifolium repens*	May 27	May 31	.....	.....	May 29	May 24	May 29	May 24	May 18
23.	*Lotus corniculatus*	May 31	June 7	June 13	.....	May 27	May 17	.....	May 23	May 20
24.	*Vicia Cracca*	.....	.....	June 14	.....	June 26	June 15	.....	June 30	June 25
25.	*Vicia sepium*	Apl. 30	Apl. 24	May 1	May 17	May 22	.....	.....	May 15	Apl. 28
26.	*Lathyrus pratensis*	June 4	June 11	June 15	.....	June 8	June 14	.....	June 9	June 4
27.	*Prunus spinosa*	Apl. 8	Apl. 11	Apl. 9	Apl. 8	.....	Apl. 4	Apl. 8	Apl. 14	Mar. 23
28.	*Spiræa Ulmaria*	.....	June 7	June 1	.....	June 21	June 17	.....	June 24	June 14
29.	*Potentilla anserina*	May 26	Juue 3	May 26	May 21	May 20	May 13	May 15	May 21	May 15
30.	*Rosa canina*	June 2	June 5	June 6	.....	June 3	June 1	June 2	June 3	June 3
31.	*Pyrus Aucuparia*	.....	May 24	.....	.....	.....	.....	.....	.....	.....
32.	*Cratægus Oxyacantha*	May 20	May 18	.....	.....	May 19	.....	.....	.....	.....
33.	*Epilobium hirsutum*	July 8	July 10	July 7	.....	July 6	July 8	.....	July 12	July 8
34.	*Epilobium montanum*	June 17	June 15	June 17	.....	June 18	.....	.....	.....	June 10
35.	*Angelica sylvestris*	.....	.....	Aug. 1	.....	.....	.....	.....	.....	July 29
36.	*Daucus Carota*	.....	.....	.....	.....	.....	.....	.....	July 5	.....
37.	*Hedera Helix*	Sept. 23	.....	.....	.....	.....	.....	.....	.....	Sept. 27
38.	*Cornus sanguinea*	June 12	Juue 13	.....	.....	.....	.....	.....	.....	.....
39.	*Syringa vulgaris*	May 19	May 17	.....	.....	May 14	.....	.....	.....	.....
40.	*Galium Aparine*	May 27	May 25	May 20	May 19	May 17	May 13	May 14	May 23	May 15
41.	*Galium verum*	July 1	Juue 25	June 19	.....	July 5	July 8	July 5	July 4	June 30
42.	*Dipsacus sylvestris*	.....	.....	Aug. 1	.....	Sept. 27	.....	.....	July 28	July 24
43.	*Scabiosa succisa*	.....	.....	Aug. 1	.....	.....	.....	.....	.....	July 24
44.	*Petasites vulgaris*	.....	.....	Mar. 31	.....	.....	.....	.....	.....	Mar. 18
45.	*Tussilago Farfara*	Feb. 25	Feb. 28	Feb. 16	Feb. 22	.....	.....	Feb. 22	.....	Feb. 24
46.	*Achillea Millefolium*	June 24	June 15	July 1	.....	.....	.....	.....	July 2	June 23
47.	*Chrysanthemum Leucanthemum*	May 26	May 25	May 21	May 31	May 28	May 20	...	.....	May 18
48.	*Artemisia vulgaris*	.....	.....	.....	.....	Sept. 7	Aug. 16	.....	July 31	Aug. 3
49.	*Senecio Jacobæa*	July 1	June 20	July 1	.....	July 12	July 25	July 7	.....	Juue 29
50.	*Centaurea nigra*	.....	June 28	July 1	.....	.....	June 14	.....	.....	June 20
51.	*Carduus lanceolatus*	.....	June 21	June 22	.....	July 26	June 20	.....	.....	June 17
52.	*Carduus arvensis*	June 2	July 8	May 31	.....	July 4	.....	.....	.....	Juue 17
53.	*Sonchus arvensis*	July 8	July 9	July 10	.....	.....	July 22	.....	July 7	July 9
54.	*Hieracium Pilosella*	.....	May 22	May 4	.....	June 5	.....	.....	.....	May 15
55.	*Campanula rotundifolia*	.....	July 9	July 3	.....	.....	July 7	July 8	July 14	July 8
56.	*Ligustrum vulgare*	.....	June 25	.....	.....	June 18	.....	.....	.....	.....
57.	*Convolvulus sepium*	.....	.....	June 30	.....	June 29	July 17	.....	July 9	July 11
58.	*Symphytum officinale*	.....	May 28	May 24	May 12	May 20	.....	.....	.....	May 6
59.	*Pedicularis sylvatica*	.....	.....	June 1	.....	.....	.....	.....	.....	May 12
60.	*Veronica Chamædrys*	Apl. 28	Apl. 23	Apl. 23	May 15	.....	Apl. 17	.....	.....	Apl. 21
61.	*Mentha aquatica*	.....	.....	Aug. 1	.....	.....	.....	.....	.....	July 31
62.	*Thymus Serpyllum*	.....	June 30	June 7	.....	.....	.....	.....	.....	June 8
63.	*Prunella vulgaris*	June 30	June 29	June 21	.....	.....	.....	.....	.....	June 18
64.	*Nepeta Glechoma*	Mar. 18	Mar. 17	Mar. 23	.....	Mar. 29	.....	Apl. 3	.....	Mar. 25
65.	*Galeopsis Tetrahit*	.....	.....	June 13	.....	.....	June 17	.....	.....	Juue 27
66.	*Stachys sylvatica*	June 9	June 13	June 12	.....	June 6	.....	.....	.....	June 6
67.	*Ajuga reptans*	May 19	May 17	.....	.....	May 20	.....	.....	May 12	May 3
68.	*Primula veris*	Apl. 8	Apl. 1	Mar. 26	Mar. 26	Mar. 30	Apl. 7	Apl. 5	Apl. 6	Mar. 18
69.	*Plantago lanceolata*	Apl. 28	Apl. 26	Apl. 24	May 6	.....	Apl. 30	.....	May 6	Apl. 21
70.	*Mercurialis perennis*	Feb. 2	Jan. 22	Feb. 4	Jan. 16	.....	.....	.....	.....	Feb. 15
71.	*Ulmus montana*	.....	Feb. 23	Feb. 26	.....	.....	.....	Feb. 26	Mar. 14	Mar. 1
72.	*Salix Caprea*	Mar. 14	Mar. 5	Mar. 8	Mar. 14	.....	Apl. 7	Mar. 4	Mar. 15	Mar. 6
73.	*Fagus sylvatica*	.....	.....	.....	.....	.....	.....	.....	.....	.....
74.	*Corylus Avellana*	Jan. 27	Feb. 14	Jan. 4	Jan. 5	.....	.....	Jan. 21	Feb. 8	Jan. 27
75.	*Orchis maculata*	June 2	June 11	June 11	.....	.....	June 3	.....	June 7	June 4
76.	*Iris Pseud-acorus*	June 3	June 6	June 7	.....	June 12	June 16	.....	June 6	June 3
77.	*Narcissus Pseudo-narcissus*	.....	Mar. 18	Mar. 5	Mar. 1	.....	.....	Mar. 4	.....	Mar. 4
78.	*Galanthus nivalis*	Jan. 20	Jan. 20	Jan. 14	.....	Jan. 17	.....	Jan. 20	Jan. 22	Jan. 21
79.	*Scilla nutans*	Apl. 21	Apl. 12	Apl. 18	May 7	.....	Apl. 17	.....	Apl. 26	Apl. 14

Frog spawn was observed at Harpenden on the 4th of March, at Hertford on the 6th, at Watford on the 15th, at Croxley on the 17th, at Royston on the 21st, and at Fanhams Hall on the 7th of April.

In the accompanying table, giving the dates of flowering of the plants in the Meteorological Society's list,* a column is added as before showing the means of the earliest dates recorded for the period of observation. Of the 79 species, 37 have been observed every year of the eight from 1876–83, 10 seven years, and 14 six years. There are therefore 61 species which have been observed at least six years. Excluding the ivy, which comes into flower too late to be grouped with the other species, we have 60 species which have been observed a sufficient number of years to be reliable tests of the state of vegetation in 1883 from about the end of January to near the end of July. Of these 60 species, 37 came into flower earlier than the mean of 1876–83, 20 later, and 3 on the same day as the mean, showing that vegetation may be considered to have been generally forward in 1883. The average state of forwardness over the mean of 1876–83 is 3·1 days.

Half the species come into flower on the average by the middle of May, and, considering this period as spring, and from the middle of May as summer, 19 of the 30 spring flowers showed themselves before their mean date, and 11 after it, while 19 of the summer flowers showed themselves before their mean date, 8 after it, and 3 on the same day as the mean. The average state of forwardness of the spring flowers was 2·8 days, and of the summer flowers 3·4 days.

Dividing now the period of observation into three, each division represented by 20 species, the average date of the first 20 species, from 21st Jan. to 21st April, is 6·2 days early; of the next 20, from 21st April to 4th June, 2·2 days late; and of the last 20, from 5th June to 24th July, 5·2 days early, showing that although there was a general state of forwardness, there was a decided retardation about the middle of the period of observation.

The same result comes out even more clearly by dividing the period into six, nearly coincident with the six months from February to July, each period being represented by 10 species. The average for February is 14·4 days early, for March 2·0 late, for April 4·1 late, for May 0·4 late, for June 3·3 early, and for July 7·1 early.

The retardation after the very early average for February seems to be due entirely to the severe frosts and continued cold of the month of March, the effect of which is apparent from about the middle of March to the middle of May.

* In addition to the tabulated records the following observations were made in the neighbourhood of Watford by Dr. Brett:—

1. *Anemone nemorosa*,	April 10	14. *Malva sylvestris*,	June 14
5. *Papaver Rhœas*,	June 3	30. *Rosa canina*,	,, 4
12. *Lychnis Flos-cuculi*,	,, 3	58. *Symphytum officinale*,	,, 12
13. *Stellaria Holostea*,	April 18	68. *Primula veris*,	April 10

The following is a list of the species from the observation of which these results have been derived, arranged in accordance with their mean date of flowering.*

For February (Jan. 21 to Mar. 5).

78. *Galanthus nivalis.*
74. *Corylus Avellana.*
10. *Viola odorata.*
70. *Mercurialis perennis.*
2. *Ranunculus Ficaria.*
45. *Tussilago Farfara.*
71. *Ulmus montana.*
77. *Narcissus Pseudo-narcissus.*
9. *Draba verna.*
72. *Salix caprea.*

For March (Mar. 11 to Apl. 20).

1. *Anemone nemorosa.*
44. *Petasites vulgaris.*
68. *Primula veris.*
4. *Caltha palustris.*
27. *Prunus spinosa.*
64. *Nepeta Glechoma.*
13. *Stellaria Holostea.*
7. *Cardamine pratensis.*
79. *Scilla nutans.*
69. *Plantago lanceolata.*

For April (Apl. 21 to May 15).

60. *Veronica Chamædrys.*
3. *Ranunculus acris.*
17. *Geranium Robertianum.*
25. *Vicia sepium.*
67. *Ajuga reptans.*
11. *Polygala vulgaris.*
58. *Symphytun officinale.*
59. *Pedicularis sylvatica.*
29. *Potentilla anserina.*
40. *Galium aparine.*

For May (May 15 to June 3).

54. *Hieracium pilosella.*
22. *Trifolium repens.*
47. *Chrysanthemum Leucanthemum.*
23. *Lotus corniculatus.*
12. *Lychnis Flos-cuculi.*
5. *Papaver Rhœas.*
30. *Rosa canina.*
75. *Orchis maculata.*
26. *Lathyrus pratensis.*
76. *Iris Pseud-acorus.*

For June (June 5 to 23).

14. *Malva sylvestris.*
66. *Stachys sylvatica.*
62. *Thymus serpyllum.*
34. *Epilobium montanum.*
28. *Spiræa Ulmaria.*
52. *Carduus arvensis.*
51. *Carduus lanceolatus.*
63. *Prunella vulgaris.*
50. *Centaurea nigra.*
46. *Achillea millefolium.*

For July (June 24 to July 25).

24. *Vicia Cracca.*
65. *Galeopsis Tetrahit.*
16. *Hypericum pulchrum.*
41. *Galium verum.*
49. *Senecio Jacobæa.*
33. *Epilobium hirsutum.*
53. *Sonchus arvensis.*
55. *Campanula rotundifolia.*
57. *Convolvulus sepium.*
43. *Scabiosa succisa.*

It will be seen from the above that our 6 groups of 10 species each in some few instances differ somewhat widely from the limits of the months which they are taken to represent, but, in order to

* The observations made in the year 1884 have been utilised in the determination of the sequence of species in this list, which therefore follows the mean of 1876-84.

obtain reliable comparative results, means should be deduced from observations of equal numbers of species. In the following remarks on the progress of vegetation during the year, in which the notes of our observers will be incorporated, a still further division will be made, and I think it will be seen that the periods are sufficiently coincident with the months to be acceptable evidence of the divergence from the mean dates of the flowering of plants throughout the period of observation.

The mean date of flowering of two of the species representing February is within the last ten days of January, and their average is 15 days early; there are 5 which flower in February, averaging 18 days early; and 3 the first week in March, averaging 8 days early. The great acceleration thus shown so early in the year is evidently due to the very mild, though damp and cloudy weather which prevailed during the winter months. The snowdrop (78) was "generally in flower in gardens" at Odsey on the 28th of January, and the dates given in the table for both Odsey and Royston are from garden specimens. The flowering of the wych elm (71) was "not general" at Hertford, "but there was only a tree in flower here and there" at the date given.

For March we have 6 species flowering in that month and 4 in April, the average of each group being 2 days late. The weather in March was much colder, though drier and brighter, than in either of the three previous months. Many spring flowers suffered from the frost, and to this appears to be due the widely-different dates given for some plants, such as the wood-anemone (1), which appeared here and there only to be quickly cut off and to have its further flowering much retarded. At Royston the sweet violet (10) "which had appeared here and there in sheltered spots in January, was cut off just as it was coming generally into flower at the end of February by the severe frost the first week in March," and "those species, such as the pilewort, which commenced flowering at the end of February, were kept at a standstill for a month, while many species, which usually commence flowering before March is out, waited for, and suddenly burst forth in the warm sunshine of April." At Harpenden "the foliage of the dog's mercury and nettle especially suffered, the foliage of many evergreens was destroyed, and on the stiffer soils much wheat died off;" but at Hertford "winter-sown wheat was looking well."

To represent April we have only 4 species whose mean date of flowering is actually within this month, and their average is 2 days late, while the other 6, flowering in May, average 6 days late. The effect of the cold weather of March appears therefore to have lasted for a considerable period, being most evident at the end of April and in the first week of May. The temperature of April was about the mean, and it was a very dry month, but not so bright as March. At Hertford "the ash trees generally were fully in flower and long before many of the oaks had even burst their buds," but this was not generally the case elsewhere. At Odsey the blackthorn (27) on the date given was only "coming into full

flower in sheltered places." At Harpenden "during the early part of April large numbers of worms were observed dead, having left their holes, and, owing to the dry and firm nature of the surface-soil, being unable to find them again. Innumerable quantities of small garden slugs (*? Limax agrestis*) were feeding on the worm-carcases."

Of the species for May, 6 come into flower within it, their average date being 2 days late; and 4 in the first three days of June, averaging 1 day early. May was the least humid month in the year, though a fair amount of rain fell. A sudden change from cold to warm weather in the early part of the month had no evident effect on vegetation until June. At High Wych the lilac (39) was "in bloom, but not generally out" on the date given. By the end of the month the foliage of the majority of our trees and shrubs was fully out, and generally luxuriant.

As the mean date of flowering of all the species tabulated for June is within the month, it will suffice to state that the first five averaged nearly 2 days early, and the second five, 5 days early, showing a gradually-increasing acceleration from May. The temperature in June was about the average. At Harpenden "oats came into ear on the 9th, and the first expanded wheat was observed on the 10th."

For July we have 5 species flowering in June, and they averaged 10 days early, while the 5 flowering in July averaged only 4 days early, showing an approach as usual to a normal state towards the middle of summer. July, however, was a very cold month, with much rain, the only warm and dry weather being within the first few days, so that, had not vegetation been very forward at its commencement, plants would probably have come into flower later instead of earlier than usual. At Harpenden "the heavy rains and somewhat wild winds broke down the corn in places, particularly where the crops were dense, and there was a tendency to mildew in the wheat grain, owing to comparative lack of sunshine." This breaking-down of the corn crops was indeed only too general in Hertfordshire, or at least in the western part of the county. At Hertford there were "no beech nuts at all," and both beech and hazel nuts were generally scarce.

For the remainder of the year there are not a sufficient number of observations to draw definite conclusions, but the few records in August and September tend to show that vegetation continued to be rather more forward than usual.

XXII.

DIATOMS: THEIR NATURE AND HABITS.

By Francis Ransom.

Read at Watford, 3rd March, 1885.

Probably few sections of that branch of Botany which may be described as distinctly microscopical in character, have received greater impetus during the last few years than that relating to the Diatomaceæ. No cabinet is now complete without several typical slides of these forms, while the number of collectors who record species and pay especial attention to this subject shows a marked increase. It is under these considerations, which appear to indicate that some general interest is now taken in the Diatomaceæ, that I am venturing to bring the subject again before your notice, although a comparatively short time has elapsed since Mr. Robinson read his excellent paper before the Society at Hertford.*

The main characteristic of a diatom, which at once distinguishes it from all allied plants, is the possession of a hard siliceous cuticle or envelope. This shell is all that is usually seen in mounted specimens, the organic interior constituents having been removed by ignition or other means. The contents thus removed, as interfering with the delineation of the delicate markings of the shell, correspond to a large extent with the materials usually found in a young vegetable cell.

Diatoms, in considerable variety, being abundant in all places where water exists, offer to all who are interested in the study of microscopic nature, exceptional opportunities for investigation. In every sea or river, pond or ditch, in fact in almost every place where water has remained, if for only a few days, exposed to the air, diatoms are to be found in greater or less abundance. Even amongst moss and on the surface of damp ground they may frequently be discovered in a living state. If some of the brown deposit which is generally seen attached to any smooth stone, washed by running water, be carefully removed and placed under a microscope, it will be found to contain large numbers of these minute organisms, if indeed it be not entirely composed of them. They can generally be detected amongst the other bodies present by the symmetry of their form and the more or less evident markings on their shells.

Although comparatively recently discovered, probably few families of the Organic Kingdoms have had a more eventful history, as recorded by their different observers. Their minute size, together with the imperfections of the instruments used in their examination, and the very uncertain and often erroneous biological ideas held by their early observers, concealed for a long time their true position in nature. According to Ehrenberg, the great German naturalist of the beginning of the present century, diatoms were discovered

* See p. 1 of present volume of the ' Transactions.'

early in the eighteenth century, and the first undoubted illustration occurs in the 'Philosophical Transactions of the Royal Society' for 1703. In 1745 William Arderon described what he terms the "oat-like animal" (evidently some *Navicula*, a genus of diatoms) associated with the "hair-like insect" as he designates the Oscillatoriæ. The most evident reason for thus placing in the Animal Kingdom the representatives of these two families, which are now regarded as undoubted vegetables, was the power that both possess of individual movement apparently quite independent of any exterior agency. A more extended knowledge of plants has clearly demonstrated that motion of this description is not confined to animals, but is also frequent amongst the lower forms of vegetable life. At the beginning of this century much confusion existed, and the Naviculæ were regarded as one stage in the life of the Oscillatoriæ. Shortly afterwards a remarkably sceptical observer (Ingenhousz) maintained that, in certain forms at least, their characteristics were not sufficiently defined to warrant their being placed either amongst animals or amongst plants, and he considered that their true position was in the Mineral Kingdom. Such degradation however was not lasting, and in 1816 a distinction was made, and some species were classed as animals, while others were regarded as plants. De Candolle and others correctly regarded the whole family as vegetables. About the year 1822, Bory de St. Vincent, being unable to satisfy himself in placing several of the lowest forms of life amongst vegetables or animals, created a sort of intermediate Organic Kingdom, which he called Arthrodiées, and in which many diatoms were included. In 1831 Ehrenberg remarks that he had succeeded in establishing their place in the Animal Kingdom, and they are thus classed in his valuable work on the Infusoria. Here they appear to have remained undisturbed for some time, but gradually, as general biological knowledge increased, and as the microscopes at the disposal of observers became greatly improved, doubt began to arise, and in 1853 the Rev. William Smith, in his standard work entitled 'A Synopsis of the British Diatomaceæ,' unhesitatingly classifies the whole family as a Natural Order in the Sub-class Algæ of the Vegetable Kingdom. Here they still remain, and there seems no probability of any further change. The desmids have frequently been classed with diatoms, but the absence of any siliceous cuticle, besides other important differences, has now caused them to be regarded as a separate order. Thus we find that during their comparatively short existence in the domain of science, diatoms have been allotted to each of the three kingdoms in turn, and have also for a short time lived in a fourth, which was brought into existence largely for their benefit.

Having briefly reviewed the history of the Diatomaceæ, it is now necessary to enter more fully into their structure. Each cell, or frustule as it is termed, is either free, attached to one or more of its own species, fixed to some foreign body, or enclosed with many others in a gelatinous envelope. Each frustule is seen to possess

two valves placed together in a position somewhat similar to a closed bivalve shell. Within this shell is found a yellowish-brown or occasionally green colouring matter or endochrome, which is similar in composition to the chlorophyll of most plants and evidently capable of performing similar functions. Diatomine was the term employed by Nägeli to indicate the colouring matter of diatoms, which he considered to be a simple compound. The absorption-spectra produced by chlorophyll are also obtained by diatomine, indicating at least a close similarity in their constitution. The colour of diatomine is readily changed to an emerald-green by the application of heat, alcohol, or acid. On adding chloroform to a diluted alcoholic solution, Petit found that on separation the whole of the yellow colouring matter was left in the alcohol while the chloroform was coloured green by a substance probably identical with ordinary chlorophyll. Some extraordinary instances have been given relative to the apparent power of this endochrome to resist decomposition, a character which, I believe, is entirely absent in the usual colouring matter of plants. Brun relates that some diatoms which he had collected in the Sahara and kept in the water in which they were found, preserved their endochrome in good condition for four years. The same authority also relates that he had seen fossil diatoms from a large deposit in Holland, and which must have been buried for centuries, present occasional specimens in which the endochrome was still yellow and transparent, although it had become somewhat thicker and more plastic. He states his conviction that this only applies to specimens which had reached perfect maturity, and whose valves were still tightly closed. Although, however, when found, the frustule may be hermetically sealed, thus preserving the contents from exterior agencies, it is difficult to understand why, during the early stages of fossilization, foreign matter should not enter through the apertures which exist at the extremities of all frustules. It would be well to receive still further confirmation before regarding it as conclusive that undecomposed endochrome actually exists under these conditions.

Protoplasm is also necessarily present in the frustule, but remains invisible until coloured by some special re-agent. It is then seen attached to the shell and occupying a position similar to that of the primordial utricle in most vitally active cells.

Unlike the great majority of plants, diatoms are believed to contain no starch. It is possible that traces may yet be discovered, but if present at all the quantity must be exceedingly small. Starch being now considered to be one of the first-formed products of assimilation when chlorophyll decomposes the carbon-dioxide of the atmosphere, it would be naturally expected to be similarly formed under the action of diatomine. In the centre of the fluid contents of the frustule is frequently seen a small transparent globular body, which from its position and character has been termed the nucleus; it is doubtful whether this has any connection with the nucleus found in the protoplasm of young cells. There

is also usually present a kind of oil existing in minute globules in various parts of the frustule. In the 'Micrographic Dictionary' it is suggested that these globules represent the starch-grains frequently found in confervoids. On drying and heating diatoms a peculiar odour is emitted which has been ascribed to this oil.

The remainder of the interior space is occupied by water, which is continually passing through the minute apertures at the extremities of the frustule. A constant current is thus maintained, and, as the water charged with carbonic acid passes through, the process of assimilation occurs, the carbon being retained and the oxygen liberated. This oxygen, being less soluble than the carbonic acid, may frequently be seen rising in bubbles to the surface of the water wherever there is any large aggregation of diatoms below. This power of liberating oxygen is one of the strongest reasons for placing the order in the Vegetable Kingdom. Several of the mineral materials dissolved in the water are also retained for use, including silica that is required for the construction of the valves, and nitrogen compounds for the formation of protoplasm.

The markings on the valves of diatoms have recently received a large amount of careful examination, and many points respecting their structure have been explained. A summary of these, together with the results of a large amount of valuable work by Dr. Flögel, has recently appeared in the 'Journal of the Royal Microscopical Society.' Similar investigations have also been recorded by J. D. Cox in the 'American Monthly Microscopical Journal.' The inferences drawn from these researches indicate that the markings of these shells are due to the various forms of depressions and inequalities in the siliceous envelope, and that no single theory is applicable to all the appearances. Owing, however, to the extreme minuteness of these markings, great difficulty is experienced in the investigation of them. Some interesting phenomena, which might at first be supposed to throw some light on the construction of the diatom-valve, were investigated by Schultze with this object. On adding sulphuric acid to a mixture of powdered fluor-spar and sand, a colourless gas (silicon-tetrafluoride) is evolved, which on coming in contact with aqueous vapour deposits silica in a very finely-divided condition. On examining this deposit under the microscope it is found to consist of thin-walled vesicles of various forms and sizes. The exterior of many of these exhibit markings very similar to those which are seen on the valves of many common diatoms, such as *Pleurosigma* and *Coscinodiscus*. The results of Schultze's investigations tended however to show that the differences were greater than at first appeared, and he concludes that the sculpturings of diatom valves and siliceous pellicles are in reality due to wholly different conditions.

The habitat of diatoms forms of itself a subject of much interest. Roughly, they may be divided into three classes, according to the water which they inhabit. Firstly there are the fresh-water species, including all those which exist in rivers, ponds, or ditches, and indeed in any situation to which the sea has no access; secondly

we have the marine species; and lastly a much smaller number which hold an intermediate position, and are found only in the brackish water of swamps and dykes to which the sea has partial access. Although *species* can thus be described as marine, fresh-water, or brackish-water, most of the common *genera* (e.g. *Navicula*) cannot be so distinguished, being abundantly represented both in sea and river.

In connection with the habitat of diatoms, a remarkable feature is the great area over which most of the commoner species are distributed. Brun remarks that he has found in Switzerland almost all those that have been recorded in Saxony, Austria, Central France, and the neighbourhood of Paris. The same might be said of England, whose recorded species include the great majority of those of Switzerland. I have collected specimens in the Pyrenees and in Switzerland, and find nearly all to be recorded in English lists, and many to be common in this county. The usual explanation suggested for their cosmopolitan nature is, that in a dry state they are conveyed by the wind for long distances. Owing to their small size and low specific gravity, this will certainly explain their dissemination over continents and for some distances across seas.

The size of fully-developed specimens varies greatly according to the species. Amongst the larger forms of British varieties some of the *Synedræ* attain to the greatest length; *S. crystallina*, a marine form, is mentioned by Smith as measuring rather over $\frac{1}{4\,0}$th inch. On the other hand, various species of *Achnanthidium* are frequently found to be only about $\frac{1}{2\,5\,0\,0}$th inch in length. These dimensions refer, of course, to the *single* frustule; in those species in which the frustules remain attached to each other, filaments are commonly found of considerable length. Some idea of the extreme minuteness of the smallest varieties is indicated by a calculation made by Ehrenberg, who estimated that a space of one cubic inch could contain 40,000,000 specimens.

Many diatoms possess a remarkable power of enduring great variations of temperature without injury, and of existing in other conditions which are usually fatal to vegetable life. Brun relates that he has found living specimens in the melting snow of the High Alps, and it is known that they exist for months on dry rocks exposed to the heat of the sun. Under such circumstances all vital action is suspended, but, as soon as the conditions are rendered favourable by the action of rain or sunshine, the usual functions of vitality recommence and no injury appears to have been sustained. Some extraordinary cases have been reported by various observers respecting the power of diatoms to revive after having been kept dry for a long period. Habirshaw mentions a case of resuscitation after being kept without water for six years, but I am not aware that this experiment has been confirmed. A few weeks since I moistened some specimens of *Synedra* dried in April, 1881, but could obtain no definite signs of life, although the colour of the endochrome was to some extent restored.

One of the most interesting phenomena connected with the natural history of diatoms is the power that many species possess of independent movement, a fact which has already been alluded to as a source of error to the early observers who placed them in the Animal Kingdom. Various theories have been suggested to explain the cause of this motion. Nearly all come under one of the three following heads—firstly, existence of endosmotic and exosmotic currents; secondly, existence of cilia on some part of the frustule; and thirdly, existence of some exterior or protruding protoplasm. The hypothesis that the movements are caused by osmotic currents, originated by Nägeli in 1849, was for some time the most popular theory, and probably still numbers many adherents. That such currents do exist is to be expected, but that they are sufficiently powerful and varied to account for these propulsions, is scarcely probable. The motion is described by the Rev. William Smith, who inclined towards the osmotic theory, in his 'Synopsis of the British Diatomaceæ,' as follows:—"This motion is of a peculiar kind, being generally a series of jerks, producing a rectilinear movement in one direction, and a return, upon nearly the same path, after a few moments' pause, by another series of isochronal impulsions. The movement is evidently of a mechanical nature, produced by the operation of a force not depending upon the volition of the living organisms. An obstacle in the path is not avoided, but pushed aside; or, if it be sufficient to avert the onward course of the frustule, the latter is detained for a time equal to that which it would have occupied in its forward progression, and then retires from the impediment, as if it had accomplished its full course." This is an accurate description of the more regular of these movements, but it is frequently noticeable that considerable digressions occur from the rectilinear course without any apparent obstacle being encountered. It is also observed that the direction is to some extent mechanically regulated by the shape of the frustule, as in the crescent-shaped *Cymbella*, whose course usually describes an arc of a circle. Dr. Carpenter in his sixth edition of 'The Microscope' still favours the osmotic theory, and endeavours to dispel the objection that such motion is not observable in other unicellular organisms by stating that there are no other such organisms which are so nearly surrounded by an impermeable envelope and consequently in which osmose is limited to so small a portion of the cell-wall. The fact, however, that no current can be detected in the water in proximity to either extremity of the moving frustule, indicates that the passage of liquid through the cell can exert but very little force. Another objection to both this and the ciliary theory is that diatoms appear to be only capable of movement when in contact with some solid body. If either of these hypotheses were correct, it might be supposed that such contact would be an obstruction rather than an assistance.

The ciliary theory has now been generally abandoned, although it has occasional revivals which create some sensation at the time of their appearance. The idea was first propounded by Ehrenberg

from observation made on *Surirella gemma*, a common marine form, from the shell of which he maintained that long delicate threads projected, which the "creature" voluntarily drew in or extended. Thread-like processes consisting of fungoid growth or parasitical algæ are not unfrequently met with, similar to those here described, but that they have any connection with the movement of the frustule, beyond a tendency to decrease its speed, is not at all probable. The 'Journal of the Royal Microscopical Society' for June, 1884, reports one of the latest of these revivals, in which projecting filaments are described as causing motion in foreign particles when the frustule passes near, but apparently without being in actual contact. A rather novel modification of the ciliary theory is suggested by Mr. J. C. Adams in the 'American Monthly Microscopical Journal' for 1883, to the effect that the cilia exist within the frustule and act against the current of water passing through.

The third hypothesis, which supposes the presence of protoplasmic material exterior to the siliceous envelope, has of late received the most supporters, who, however, differ greatly in respect to details. Probably the ablest contribution to this theory is a paper by Professor Schultze, published in 1865. Professor E. Ray Lankester makes special reference to this publication in the 'Popular Science Review' for 1866, where he describes it as "ending in a satisfactory and conclusive explanation of the method and nature of locomotion in these organisms." This opinion unfortunately has not been universally adopted, and has not hindered the publication of numerous modifications and rival theories. Schultze concluded, after a long series of most careful and minute observations, that the motion was caused by the protrusion of hyaline protoplasm through the apertures which exist in the raphe, or line of suture connecting the two valves. The protoplasm thus extended is supposed to form a moving band or foot-like process, which, passing along the exterior of the shell, comes in contact with some solid body and thus forces the diatom in the opposite direction. In support of his theory, Schultze discovered, with the aid of very powerful objectives, considerable agitation amongst certain minute granules of protoplasm immediately within the apertures, but was unable to distinguish any such movement on the exterior of the frustule. This, however, he accounted for by supposing the apertures to be too minute to allow the exit of these granules, by which alone the protoplasm was visible, consequently the exterior band would be perfectly transparent. He states that in the specimens examined (*Pleurosigma angulatum*) the diatom always moved with the raphe in contact with some foreign body. This, however, is not invariably the case with other species, some of which may frequently be observed moving on their secondary sides, on which the raphe is absent. Several later writers have suggested that free as well as stipitate diatoms are surrounded by an extensible membrane, and that the movements are in some way connected with this material. A confident statement is made by a writer

(Anderdank) in the 'American Monthly Microscopical Journal' for 1883 to the effect that the movements are due to what he terms a "mobile pallium" which partially surrounds the frustule. This he describes as "no mere theory," having stained, detached, and mounted many of these gelatinous envelopes. Another hypothesis, suggested by negative rather than positive results, is that the motion is entirely due to purely mechanical forces, such as heat, light, and capillarity.

Although the motion of diatoms is slow compared with that of many of the animal organisms with which they are found, it is not insignificant if regarded in relation to their size. The most rapid in movement is *Bacillaria paradoxa*, which Smith found to proceed at the rate of about an inch in three minutes. It has been calculated that a snail crawling at the same proportionate rate for its size would traverse half a mile in an hour.

Another subject of interest in connection with the natural history of diatoms, and requiring further investigation, is that relating to the methods of reproduction. The simplest and most usual mode is self-division, corresponding with the ordinary cell-division as seen in all branches of the Vegetable Kingdom. The first step of the process probably consists in the division of the interior protoplasm by a growth of cellulose. This is soon followed by the development of two fresh siliceous valves exactly similar in structure to those of the original frustule, and growing up opposite to each in the interior of the cell. As soon as these new valves are fully developed, the frustule (if that of a free species) splits from end to end, and two diatoms result, each possessing one of the original and one of the newly-formed valves. The time occupied by a healthy and vigorous frustule for one such process has not been definitely determined, but is estimated by Smith to be about twenty-four hours. Supposing this to be correct, a simple calculation will show that the progeny of a single organism in a month of thirty-one days will amount to upwards of 1,000,000,000. Although it is not probable that the conditions would be sufficiently favourable to secure such a result, the fact will help to explain the remarkable increase in diatoms which may frequently be seen in a puddle of rain-water that has remained undisturbed for a few days. Another method of reproduction consists in the conjugation of two frustules, when remarkable changes take place. The protoplasmic contents of each appear to unite; a membranous bag is developed around them, which resolves itself into a sporangium, and, various changes having occurred, several fresh frustules finally result. Various modifications have been observed in the process according to the species examined.

In estimating the results produced by diatoms in the economy of Nature, we find that the imperishable character of the siliceous valves plays an important part. In most parts of the world where search has been made, large deposits of so-called fossil diatoms have been discovered. Whether fossil, or even sub-fossil, is a correct term to apply to these remains, when, as is frequently the case,

they exist in a condition almost the same as when originally formed, is perhaps open to question. Occasional specimens are met with in recent geological strata. One of the most interesting discoveries of this kind was made by Mr. W. H. Shrubsole, who found them to exist in the London Clay. Most of the specimens, some of which remain unbroken, have a deposit of iron pyrites within the frustule, which, however, can be removed with dilute acid. A few new species have been detected, but the great majority are identical with those living at the present time. Deposits of almost pure diatoms exist in the beds of several small lakes in North Wales, Scotland, and Ireland. In Norway and Sweden a remarkable use is made of deposits of this description, which are termed berg-mehl, or mountain-flour. In bad times it is the custom of the natives to mix this material with their dough in making bread. It has been suggested that any nourishment derived from it is due to the presence of some organic matter, but a more probable explanation of its use is that, by simply enlarging the bulk of bread eaten, it increases its value as nutriment. One of the best known and most remarkable of diatomaceous deposits exists in Virginia, where the town of Richmond is actually built upon a stratum eighteen feet in thickness, consisting almost entirely of valves of diatoms of past ages. Another interesting source is guano, where we find that these indestructible shells have passed uninjured through the stomachs of sea-birds. They are often present in such abundance that some of the remarkable value of this manure in promoting the growth of cereal crops may be due to the silica thus contained within it, and which is so essential for the food of all grasses. Some new species were also discovered in the stomachs of tinned Japanese oysters exhibited at the Fisheries Exhibition in 1883.

Diatomaceous earth is much used for polishing hard surfaces, and a well-known variety found in Austria is of special value for this purpose. Owing to the extreme minuteness of the valves a similar deposit is used in the manufacture of dynamite, as affording silica in a finely-divided condition. Besides these commercial uses, a most valuable service has been rendered by certain diatoms in providing tests for the quality of object-glasses. At one time the power of resolving certain of the more delicate markings on various species of *Pleurosigma* was regarded as an accurate test for the defining power of the lens, but it has now been shown that this power depends upon the magnitude of the angular aperture of the objective. Much indirect good has nevertheless resulted from the prominence to which diatoms thus attained, by inducing increased efforts on the part of makers to bring their glasses to a higher state of perfection.

A rather novel use was made of diatoms a few years ago by Dr. Bossey, resulting in a paper entitled "Thames Mud in relation to Sanitary Science." It is well known that large deposits of mud are continually being formed in the Thames in the neighbourhood of Chelsea and elsewhere, and it became an important matter to determine whether these accumulations had any connection with

the sewage-matter discharged into the river lower down. With a view of obtaining some reliable information on this point, the diatomaceous forms from a number of these deposits were examined, with the result of finding numerous specimens of marine species even so high up as at Richmond. This indicated the power that the tide possesses of conveying solid materials far up the river, and suggested the probability that sewage-matter may have some connection with the formation of these banks.

From these facts we perceive that the uses to which diatoms are applicable are of value and variety, and that the study of their nature and habits deserves careful attention. To the fact that such investigation is amply repaid by the interest which it inspires, I can bear full testimony, and can confidently recommend the study to all whose tastes incline towards microscopical science. Amongst the various problems yet unsolved in connection with the life-history of these minute organisms, those relating to their movements and reproduction offer exceptional opportunities for further research.

I append a list of species found in Hertfordshire in addition to those enumerated by Mr. Robinson in 1883.

Cymbella Ehrenbergii.
Amphora minutissima.
Cyclotella operculata.
Surirella splendida.
,, ovalis.
,, Craticula.
,, Amphioxys.
Cymatopleura parallela.
Nitzschia plana.
,, tenuis.
,, palea.
Navicula sphærophora.
,, dicephala.
,, pusilla.
,, rostellum.
Navicula Gastrum.*
Pinnularia tabellaria.
,, borealis.
Synedra minutissima.
,, pulchella.
Gomphonema dichotomum.
,, Cygnus (Ehr.)
Odontidium Harrisonii.
Himantidium gracile.
,, Arcus.
Fragillaria capucina.
,, virescens.
Achnanthes ventricosa.
Orthosira arenaria.
Melosira varians.

* In lieu of *Stauroneis truncata* as previously recorded.

XXIII.

NOTES ON BIRDS OBSERVED IN HERTFORDSHIRE DURING THE YEAR 1884.

By John E. Littleboy.

Read at Watford, 3rd March, 1885.

In presenting to our members my seventh annual report, I have the pleasure of announcing the addition of twelve species to our register, a number I certainly never expected again to reach. The birds which I am now about to mention—the fire-crest, the waxwing, the mealy redpoll, the chough, the little bittern, the black tern, the kittiwake, the great northern diver, the gannet, the sheldrake, the garganey, and the shoveller—increase our number to 166 species. Information respecting the Avifauna of the Banbury district, which comprises the northern portion of Oxfordshire, and parts of Warwickshire and Northamptonshire, has been very ably and zealously collected by Mr. Oliver V. Aplin, of Banbury, and he has succeeded in registering 180 species. I may state that the Cherwell, a branch of the river Thames, runs right through the district, and affords a congenial resort to multitudes of waterfowl, and that Mr. Aplin has registered all well-authenticated species, however remote may have been the date of their occurrence. When it is remembered that the 166 species on our own register have all been recorded within the last seven or eight years, and that we have in Hertfordshire no attractions for water-fowl at all comparable to the Cherwell, I think we may consider that satisfactory progress has been made.

As on former occasions, I shall now proceed to notice seriatim the birds just mentioned. Mr. Henry Seebohm has very kindly supplied me with manuscript notes respecting nearly all of them. In order to avoid the repetition of his name, I shall simply mark all extracts from his notes with inverted commas.

1. The Fire-crest (*Regulus ignicapillus*).—Mr. S. Chapman, of Bennington, near Stevenage, informs me that these exquisite little birds are occasionally to be seen during the autumn months in a plantation of larch and Scotch firs, of about seven acres in extent, which stands upon a good slope, facing the south, within about fifty yards of his own house. He states that large numbers of gold-crests are constantly to be found in the same wood, that he has watched them most carefully, and has had every opportunity of distinguishing between the two species. "The fire-crested wren has a very restricted range,* its northern limit appearing to be the Baltic provinces. It winters in the south of France, in some parts of Italy, in the Islands of Sardinia and Malta, and is very common in Algeria. The fire-crests that visit England are probably accidental visitors from the Continent; they appear most frequently in Cornwall, and the inference is that they are wanderers from France, where the bird is common in pine forests."

* Seebohm's 'British Birds,' vol. i, p. 458.

2. The Waxwing (*Ampelis garrulus*).—For the record of my next bird I am also indebted to Mr. Chapman: he writes to me that his brother shot a pair of waxwings in 1881, near the town of Ware, and that they are still in his possession. I am also informed by Dr. A. T. Brett that a waxwing was shot about ten years ago in Watford fields. The waxwings* are a very small sub-family, consisting of birds having the wing of a starling, the foot of a shrike, and a bill intermediate between that of a shrike and a swallow. The waxwing is an extremely irregular migrant; it breeds principally in Lapland, but was met with by Mr. Seebohm during the breeding-season in the valleys of the Petchora and Yenesay. In the winter of 1866-67 it visited England in extraordinary numbers. In that year Mr. Gunn, the well-known naturalist of Norwich, had more than a hundred of these birds passed through his hands, and he found on examination that their food had consisted of berries of the guelder rose, the dog rose, the white thorn, and the privet. "A gipsy migrant like the waxwing, that occasionally visits the British Islands in great numbers, is quite as likely to be found in Hertfordshire as in any other county."

3. The Mealy Redpoll (*Linota linaria*).—A mealy redpoll was taken in nets, near Ivinghoe, at the foot of the Chilterns, about the end of September, 1883, by Mr. Banfield, bird-dealer, Hemel Hempstead. It was shown to me at the time, but I accidentally omitted to mention it last year. The mealy redpoll is an irregular winter visitant to the British Isles. It is a circumpolar bird, breeding at or near the limit of forest growth. In its habits, it is nearly allied to its congener, the lesser redpoll, but is distinguishable from it by its larger size and the generally lighter and greyer appearance of its plumage.

4. The Chough (*Fregilus graculus*).—Mr. Henry Cross, of Harpenden, reports having met with a chough, which he describes as a large black bird with a reddish-yellow beak, on the eastern side of the Midland Railway, near Beech-bottom Wood, on the 27th of May. A correspondence has taken place in the 'St. Albans Times' respecting the occurrence of this bird, and it has been suggested, as choughs are frequently sold to visitors at Trevena in Cornwall, where they are always to be found, that the bird in question may probably have found its way into Hertfordshire by rail rather than by wing. I can only remark in reply that the newspaper correspondence has failed to elicit any information respecting it, and I think that in the absence of any such information, I am bound to accept it as an accidental visitor to our county. The chough is a rare bird and is yearly becoming scarcer. It is essentially a "bird of the rocks,"† and still breeds in Cornwall, Devon, Anglesea, and some places on the Welsh coast. "The appearance of the chough, which is not a migratory bird, and is confined in our islands to the rocky coasts of the west, can only be accidental in Hertfordshire. It is possible that a bird may have been caught in a heavy 'sou-

* *Ib.* vol. ii, p. 1. † *Ib.* vol. i, p. 577.

wester' and have been driven up from Cornwall or the Channel Islands."

5. The Little Bittern (*Ardetta minuta*).—A little bittern was shot on the 17th October, by Mr. E. N. Beningfield, of Broxbourne, near the Carthagena Weir. It has been mounted by Mr. Gunn, of Norwich. The little bittern is one of the most beautiful of our waders. It is the smallest of its class, "its body * being scarcely larger than that of the fieldfare." It is resident † in the Azores, Madeira, Algeria, and to a limited extent in Egypt. It is a night feeder and at present is only a rare and accidental summer visitor to the shores of England. "Probably," writes Mr. Seebohm, "the country has become too civilized, and high farming has driven it away, or possibly the district is not civilized enough, and it has succumbed to the poacher. The paradise of the ornithologist, as well as of the little bittern, can only be found in this country where bad farming is combined with strict game-preserving."

6. The Black Tern (*Hydrochelidon nigra*).—Mr. E. P. Thompson, of Elstree, informs me that a black tern was taken on the Elstree Reservoir, about two years ago, as it sat upon one of the buoys to which boats are attached. "Not a century ago the black tern bred in the Lincolnshire fens, on the Norfolk broads, and in the Kent marshes; now it only passes our shores in spring and autumn on migration, and its occurrence as far inland as Hertfordshire can only be regarded as accidental."

7. The Kittiwake (*Rissa tridactyla*).—Mr. Henry Lewis, of St. Albans, informs me that a kittiwake gull was picked up dead, at Colney, near St. Albans, in February last. It was taken to Mr. Luff, who states that he could not find any appearance of injury on any part of it, and that it had died apparently from exhaustion or starvation. The kittiwake is one of the commonest of our English gulls. It is a sea-bird, and is but seldom met with in the inland counties. It breeds in immense numbers on particular portions of the coast, and although not absolutely a migrant, is much more abundant in summer than in winter. In appearance it very much resembles the common gull, but is somewhat smaller, and may always be distinguished from it by the absence of a hind toe.

8. The Great Northern Diver (*Colymbus glacialis*).—A great northern diver, in immature plumage, was shot on Elstree Reservoir by Mr. Bright's keeper, in the month of October last, and has been cleverly mounted by Mr. Bowers, of Watford. I am informed by Mr. E. P. Thompson, of Elstree, that a bird of the same species was shot on Boxing-day, 1876, by Mr. Willshin. The great northern diver is the largest of its genus, and has frequently been found to weigh as much as 10 lbs. It is essentially a sea-fowl, it but rarely leaves the water, and walks, when on land, with the greatest difficulty. "It visits our shores only in winter. In very stormy weather examples sometimes occur inland, but these are principally

* Montagu's 'Ornithological Dictionary,' 1883, p. 48.
† Seebohm's 'British Birds,' vol. ii, p. 510.

birds in immature plumage. It is not known to breed, in any number, nearer to us than Iceland."

9. The Gannet (*Sula bassana*).—In August last a gannet or Solan goose was caught, in a disabled state, by some boys, on waste land at Cromb-Hyde, near Sandridge. It has been successfully mounted by Mr. Luff, of St. Albans, and is now in the possession of Mr. Archer, of Sandridge. I am indebted for this information to Mr. Henry Lewis, of St. Albans. The gannet, when mature, weighs about 7 lbs., the stretch of its wings reaching, according to Montagu, to about 6 feet. It feeds exclusively on fish, and Mr. Booth, of Brighton, has estimated that it will readily consume ten herrings per day. Its method of fishing is peculiar, and deserves notice. When swimming it never dives, but depends solely for its success upon the length of its neck. Whenever deep fishing is desirable, "it rises * to such a height in the air as experience shows best calculated to carry it, by a downward motion, to the required depth, and then, partially closing its wings, it falls perpendicularly on its prey, and rarely without success." "So exclusively a sea-bird as the gannet seldom voluntarily strays far inland, but probably no sea-birds, not even the stormy petrel, are able to weather very severe storms, and instances constantly occur when they are driven away from their favourite haunts. Hertfordshire is a long way from any breeding-place of the gannet; none are found nearer than Lundy Island, far away to the west, or the Bass Rock still further away to the north, but in winter stray birds are distributed over the entire coast."

10. The Sheldrake (*Tadorna cornuta*).—A sheldrake was shot during the Christmas week, 1883, by Mr. Willshin, on the Elstree Reservoir. The sheldrake, which is one of the largest and handsomest of our British ducks, is resident on numerous sandy reaches of our coast-line. It nests in rabbit-holes and other hollows, constructing its nest of whatever herbage may happen to be available, and lining it with its own down. The eggs of the sheldrake have frequently been hatched under hens, and an attempt made to domesticate the young on inland ponds; but such efforts have rarely been successful.

11. The Garganey (*Querquedula circia*).—Mr. Marlborough R. Pryor has been kind enough to send me information respecting a garganey duck that was shot during Easter week, 1879, on a pond at Bennington, near the residence of Mr. Leonard Proctor. The garganey, a beautiful and delicately-marked duck, is a summer visitant to the British Isles, breeding sparingly in the eastern counties. It ranks in size between the widgeon and the teal, and has sometimes been styled "the summer teal." It is a rare bird in the inland counties, and is a welcome addition to our register.

12. The Shoveller (*Spatula clypeata*).—In the month of August, 1882, a shoveller was killed on the river Lea, near Wheathampstead, and given to Mr. George Dickenson, Leasey Bridge Farm. It is

* Yarrell's 'British Birds,' 4th ed., vol. iv, p. 159.

now in the possession of Mr. Luff, of St. Albans. "The shoveller is a spring and autumn migrant, occasionally remaining to breed." * It is readily distinguished by its bill, which spreads out at the end somewhat after the fashion of a spoon or spatula, the edges being furnished with a fine fringe, resembling a comb, by the aid of which the shoveller is able to sift from the water and mud of inland lakes and ponds the insects and worms upon which it feeds. "There is no reason why the shoveller should not breed in Hertfordshire, as it still does in Nottinghamshire and Norfolk, and as it formerly did in Kent."

The dates on which the arrival and departure of our summer migrants and other visitants have been reported, with the names of the observers, will be found in the following tables.

Summer Migrants.

Species.	Locality.	Date.	Observer.
Nightingale	Harpenden	Apl. 7	J. J. Willis.
(*Daulias Luscinia*)	Hitchin	,, 10	Hitchin F. C.
	Panshanger Park	,, 13	R. G. Austin.
	Croxley, Rickmansworth	,, 15	F. G. Lloyd.
	Hertford	,, 15	R. T. Andrews.
	Hailey Hall, Hertford	,, 15	H. C. Heard.
	Royston	,, 16	P. F. Fordham.
	Port Vale, Hertford	,, 17	Norman Thrale.
	Childwick, St. Albans	,, 19	Henry Lewis.
	Watford	,, 23	J. Hopkinson.
	Royston	,, 24	A. Kingston.
	Odsey Grange	,, 26	H. G. Fordham.
	Elstree	,, 28	E. P. Thompson.
	Hemel Hempstead	,, 28	Mr. Hall.
Redstart	Hitchin	Mar. 30	Hitchin Field Club.
(*Ruticilla Phœnicurus*)			
Chiff Chaff	Hitchin	Mar. 30	Hitchin F. C.
(*Phylloscopus collybita*)	Grove Lane, Watford	Apl. 2	J. E. L.
Willow Wren	Port Vale, Hertford	Mar. 17	Norman Thrale.
(*Phylloscopus Trochilus*)	Hunton Bridge	,, 22	J. E. L.
	Hitchin	,, 30	Hitchin F. C.
Whitethroat	Royston	Apl. 29	P. F. Fordham.
(*Sylvia rufa*)			
Lesser Whitethroat	Hunton Bridge	,, 28	Fred Warren.
(*Sylvia Curruca*)	Elstree	,, 29	J. E. L.
	ditto	May 4	E. P. Thompson.
Blackcap	Leverstock Green	Apl. 3	J. E. L.
(*Sylvia Atricapilla*)	Port Vale, Hertford	,, 5	N. Thrale.
	Elstree	,, 7	E. P. Thompson.
Sedge Warbler	Hunton Bridge	,, 27	J. E. L.
(*Calamodus schœnobœnus*)			
Red-backed Shrike	Port Vale, Hertford	May 2	Norman Thrale.
(*Lanius collurio*)	Royston	July 5	P. F. Fordham.
Spotted Flycatcher	Odsey Grange	May 10	H. G. Fordham.
(*Muscicapa grisola*)	Hunton Bridge	,, 13	J. E. L.
	Ashwell	,, 24	E. S. Fordham.
(Last seen)	Odsey Grange	Sept. 11	M. E. Fordham.

* Harting's 'Handbook of British Birds,' p. 62.

Species.	Locality.	Date.	Observer.
Pied Wagtail	Boxmoor	Jan. 3	J. E. L.
(*Motacilla lugubris*)	Near Stanmore	,, 8	J. E. L.
Swallow	Hemel Hempstead	Apl. 3	H. Wyman.
(*Hirundo rustica*)	Hitchin	,, 4	Hitchin F. C.
	Brockley Hill	,, 11	E. P. Thompson.
	Croxley, Rickmansworth	,, 15	F. G. Lloyd.
	Hertford	,, 15	R. T. Andrews.
	Hailey Hall, Hertford	,, 19	H. C. Heard.
	Watford	,, 23	J. Hopkinson.
	Boxmoor	,, 24	J. E. L.
	Odsey Grange	,, 26	H. G. Fordham.
	Royston	,, 27	P. F. Fordham.
	ditto	,, 27	A. Kingston.
(Last seen)	Odsey Grange	Oct. 15	H. G. Fordham.
House Martin	Hemel Hempstead	Apl. 3	H. Wyman.
(*Chelidon urbica*)	Cassio Bridge, Watford	,, 6	C. E. Fry.
	Boxmoor	,, 24	J. E. L.
	Harpenden	,, 26	J. J. Willis.
Sand Martin	Port Vale, Hertford	,, 3	N. Thrale.
(*Cotyle riparia*)	Hitchin	May 2	Hitchin F. C.
Wryneck	Cassio Bridge, Watford	Mar. 30	E. Moon.
(*Jynx Torquilla*)	Hitchin	Apl. 2	Hitchin F. C.
	Port Vale, Hertford	,, 4	N. Thrale.
(Last seen)	ditto	Oct. 3	N. Thrale.
Cuckoo	Cassio Woods, Watford	Apl. 5	Mrs. A. Copeland.
(*Cuculus canorus*)	Bury Grove, Aldenham	,, 9	Mr. Bright's kpr.
	Brockley Hill	,, 14	E. P. Thompson.
	Harpenden	,, 15	J. J. Willis.
	Hertford	,, 16	R. T. Andrews.
	Hitchin	,, 16	Hitchin F. C.
	Hailey Hall, Hertford	,, 19	H. C. Heard.
	Childwick, St. Albans	,, 19	Henry Lewis.
	Watford	,, 23	J. Hopkinson.
	Royston	,, 24	P. F. Fordham.
	Port Vale, Hertford	,, 25	N. Thrale.
	Royston	,, 26	A. Kingston.
	King's Langley	,, 27	J. E. L.
	Sawbridgeworth	,, 28	Miss Simpson.
	Croxley, Rickmansworth	,, 28	F. G. Lloyd.
	Odsey Grange	,, 30	F. O. Fordham.
Swift	Hunton Bridge	,, 28	Fred Warren.
(*Cypselus Apus*)	Croxley, Rickmansworth	,, 28	F. G. Lloyd.
	Port Vale, Hertford	May 2	N. Thrale.
	Hitchin	,, 5	Hitchin F. C.
	St. Albans	,, 6	Henry Lewis.
	Berkhamsted	,, 10	J. E. L.
	Boxmoor	,, 10	J. E. L.
	Hunton Bridge	,, 10	J. E. L.
	Ashwell	,, 10	H. G. Fordham.
	Royston	,, 10	A. Kingston.
	Harpenden	,, 21	J. J. Willis.
(Last seen)	Hitchin	Sept. 19	Hitchin F. C.
Turtle Dove	Odsey Grange	May 9	H. G. Fordham.
(*Turtur auritus*)	Hitchin	,, 10	Hitchin F. C.
Quail	Royston	,, 4	P. F. Fordham.
(*Coturnix communis*)			
Stone Curlew	Royston	June 1	P. F. Fordham.
(*Œdicnemus Scolopax*)			

Species.	Locality.	Date.	Observer.
Landrail (*Crex pratensis*)	Elstree	Apl. 10	E. P. Thompson.
	Hailey Hall, Hertford	,, 20	H. C. Heard.
	Hitchin	May 5	Hitchin F. C.
	Royston	,, 20	P. F. Fordham.
	Harpenden	,, 21	J. J. Willis.

Spring, Autumn, and Winter Visitants.

Redwing (*Turdus iliacus*)	Royston	Oct. 16	H. G. Fordham.
	King's Langley	,, 23	J. E. L.
Fieldfare (*Turdus pilaris*)	Hailey Hall, Hertford	Aug. 25	H. C. Heard.
	Hitchin	Nov. 8	Hitchin F. C.
Brambling (*Fringilla montifringilla*)	Hemel Hempstead (large flights)	Feb. 23	Mr. Banfield.
Hooded Crow (*Corvus Cornix*)	Royston	,, 12	P. F. Fordham.
	Odsey Grange	Mar. 2	H. G. Fordham.
	ditto	Oct. 6	H. G. Fordham.
	Hertford	,, 7	N. Thrale.
	Royston	,, 18	P. F. Fordham.
Short-eared Owl (*Asio accipitrinus*)	Weston Manor, Stevenage (a flight)	May 11	M. R. Pryor.
Woodcock (*Scolopax Rusticola*)	Nash Mills	Sept. 1	J. Evans, D.C.L.
	Royston	Nov. 1	P. F. Fordham.
	Odsey Grange	,, 17	H. G. Fordham.

Miscellaneous Notes.

Nightingale (*Daulias Luscinia*).—I am afraid that nightingales are generally becoming scarcer; they are certainly less abundant in the Hunton Bridge district than they were ten years since. About a century ago William Cowper, our Berkhamsted poet, wrote as follows:—

> "Thousands of warblers cheer the day, and one
> The live-long night."

At present the words are hardly applicable. In my own garden the notes of the sedge-warbler were quite as frequently heard throughout the nights of last summer as those of the nightingale.

Great Grey Shrike (*Lanius Excubitor*).—I am pleased again to record the occurrence of the great grey shrike; I have now done so for four consecutive years. Mr. Bowers informs me that a specimen was shot on Tyler's Farm, near Bushey, on September 23rd. It was mounted by himself.

Red-backed Shrike (*Lanius collurio*).—These birds have not been numerous on this side of the county. I was not fortunate enough to obtain the sight of a single one during the whole summer. Mr. Norman Thrale, of Port Vale, reports the nesting of four pairs in that neighbourhood; three of them built in a hawthorn hedge, where he was able to watch them, and it was, he writes, very interesting to observe the old and young birds hunting together for their food. They disappeared about the end of August.

Chaffinch (*Fringilla cœlebs*) —Dr. Brett informs me that on the 30th of January a chaffinch was found to be sitting on three or four eggs in the garden of Mr. Ricardo Palmer, at Bushey. The nest was built in a piece of cottager's kale.

Twite (*Linota flavirostris*).—This bird has been twice reported during the year. Mr. W. Hill, jun., informs me that a male bird was taken near Hitchin on the 4th of May, and two pairs were secured in nets, by Mr. Banfield, bird-dealer, Hemel Hempstead, in the month of February, near Ivinghoe.

Tree-sparrow (*Passer montanus*).—A tree-sparrow, caught at Pix Farm, near Bourne End, was brought to me by Mr. Banfield on the 13th of November. I have observed two or three tree-sparrows in my own garden during the winter.

Raven (*Corvus Corax*).—A raven is reported by Mr. Percy F. Fordham as having been seen near Royston.

Woodpeckers (*Picus major*, *P. minor*, and *Gecimus viridis*).—An unusual number of wood-peckers have been reported in 1884. Mr. G. Shrimpton, of Port Vale, reports that he has recently mounted four specimens of the greater spotted woodpecker, all shot in the neighbourhood of Hertford; he also informs me that a pair of lesser spotted woodpeckers settled on a pear tree a few yards from his own door. A green woodpecker, or, as it is commonly called, a "whetile," shot by Frederick Halsey, near the Railway Terrace, Nash Mills, was sent to me on the 3rd of February by Dr. Evans. Dr. Brett informs me, on the authority of the gamekeeper, that green woodpeckers have been very common in Oxhey Woods, and Mr. N. Thrale advises me of two having been shot and several others seen in the neighbourhood of Hertford. The green woodpecker is one of the very few English birds that is strictly non-migratory; it would seem therefore that the Wild Birds Preservation Act may possibly have exercised some influence in promoting its preservation.

Owls (*Asio Otus* and *A. accipitrinus*).—A long-eared owl is reported as shot on the 10th of April, near Odsey Grange, by Mr. H. R. Fordham, and two others as observed near Royston, on the 5th of July, by Mr. Percy F. Fordham. Mr. Marlborough R. Pryor informs me that a flight of short-eared owls was observed near his residence, Weston Manor, Stevenage, on the 1st of November; and Mr. George Shrimpton reports that one was shot in Bedwell Park, on the 1st of November.

Rough-legged Buzzard (*Buteo lagopus*).—Mr. Marlborough R. Pryor has kindly advised me of a rough-legged buzzard having been shot at Bennington in the year 1880. I applied for further particulars to Mr. Chapman, gamekeeper on the estate of Mr. Leonard Proctor, and have received from him the following interesting account:—"The rough-legged buzzard you refer to was shot on November 9th, 1880. It was a very fine bird, measuring from tip to tip of wing 4ft. 7½in., and from head to tail 1ft. 9in.; I first observed it in the early part of October. The locality is a high hill, with a large tree on the top of it, which commands an extensive view for many miles. I frequently watched the buzzard fly away, as far as the eye could reach, but it always returned to the hill. A second specimen was shot on October 30th, 1883, within a few yards of where the first was killed."

Partridge (*Perdix cinerea*).—I am informed that partridges have been very abundant during the season of 1884. The following anecdote has been sent to me by Mr. H. George Fordham, of Odsey Grange:—About the end of May, 1883, a shepherd in the employ of Mr. Richard Bowman, of Cold Harbour, on the borders of Hertfordshire and Cambridgeshire, found a hedgehog apparently surfeited with food, about eight or ten yards from the rifled nest of a partridge. It appeared that the hedgehog had killed the old bird on its nest and eaten both bird and eggs. That such was actually the case a subsequent examination proved most conclusively. The shepherd carried the hedgehog to his hut, where it was shown to Mr. Bowman. It was then killed and opened, and the fresh feathers of a partridge found within it.

Heron (*Ardea cinerea*).—Mr. A. J. Copeland informs me that when hunting on the 3rd of March, he noticed four herons rising from a small pond in Bishop's Wood, Moor Park. Herons have been repeatedly reported by Lord Ebury, but always recorded as frequenting the ornamental water in the upper grounds.

Coot (*Fulica atra*).—Mr. Henry Lewis reports that a coot, by no means a common bird in Hertfordshire, was taken near St. Albans in November.

Ringed Plover (*Ægialitis hiaticula*).—I am indebted to Mr. Henry Lewis for information respecting a ringed plover that was killed, in September last, by flying against telegraph wires, close to Park-street Railway Station. Mr. Percy F. Fordham reports that a large flight of these plovers was observed near Royston, on the 28th of October.

Dusky Grebe (*Podiceps cornutus*).—Miss W. Seebohm kindly informs me that a dusky grebe in good plumage was shot by Mr. Flitton, of Radwell, near Hitchin, and is now in the possession of Mr. Latchmore. The dusky grebe has only been reported on two previous occasions.

Dabchick (*Podiceps minor*).—In my last annual report it was my duty to record the fact that three dabchicks had been found dead in the river Beane, choked by attempting to swallow bullheads. On the 4th of February last Mr. N. Thrale was good enough to send me a specimen killed precisely in the same manner, and nearly in the same place. The bullhead still remained half-swallowed in its mouth. It is at present preserved in Dr. Brett's museum. Mr. Thrale informs me that these catastrophes only occur during unsettled weather, when the water is thick. He adds that bullheads are very plentiful in the Beane, and that he found no less than six of these ungainly-looking fishes in the stomach of a heron that had been killed on the stream. My friend Mr. Henry Manser, of Hoddesdon, has sent to me the following interesting note respecting the nesting of dabchicks:—"Last summer a pair of dabchicks made a nest of weeds, etc., floating it on the water near the island in our lake, and mooring it to the branch of a tree that hung down into the water. A strong wind detached the nest, and drove it (eggs and all) into the centre of the lake, where weeds on the surface pre-

vented it from floating further. The birds, nothing daunted, continued to sit on the eggs, which they successfully hatched, and, much to our interest and pleasure, succeeded in rearing the young."

Tufted Duck (*Fuligula cristata*).—A flight of seven tufted ducks visited the Lynch, Hoddesdon, early in the present year. I quote the following from a letter received from Mr. Henry Manser:—"The Lynch, January 26th, 1885. For the past week I have had seven specimens of the tufted diver on the lake; they are all drakes. Yesterday, whilst watching the seven strangers, six of them rose from the water and flew several times round the high forest-trees on the island, and again settled on the water. They looked very pretty during their flight. Only one out of the seven is in perfect plumage, the others are evidently last year's birds; the tuft on the head not being so long, full, and perfect as it will be in a few months hence, and the white on the breast and sides not the pure clean white of the adult bird." I ought to mention that Mr. Manser has had some pinioned tufted ducks on the Lynch pond for several years, and this fact may probably account for the visit of the seven drakes.

Little Auk (*Mergulus alle*). — Mr. J. Sharp, of St. Albans, informs me that a little auk was found dead in a field, at Symonds Hyde, near Sandridge. It is the second time that I have been able to record the occurrence of this very peculiar little sea-bird in Hertfordshire. I believe that it is never a voluntary visitor to inland districts, and its presence here can only be due to storm-pressure.

Albino Sports.—The number of albino sports, especially in the St. Albans district, appears during the past year to have been unusually large. Mr. Arthur Lewis reports having observed a milk-white jackdaw in Gorhambury Park. It was feeding with a large number of other jackdaws, and when it rose from the ground it seemed to be guarded by five or six of them. Lord Grimston, in a letter dated November 9th, informs Mr. Lewis that it has been there for some years, and that there are in the park several other more or less white birds, including a white rook, and two or three of a grey colour or with patches of white on the wing. His lordship further states that he first observed a rook with white patches on its wing about ten years ago, and that he has seen the same or similar ones, at intervals, ever since. Mr. E. W. Arnold, of Redbourn Bury, reports having met with a perfectly white wood-pigeon; and Mr. Arthur Lewis has now in his possession a cream-coloured greenfinch, not quite white, but nearly so, which was caught near St. Albans last December.

General Remarks.

I need hardly remark that observations, taken and recorded, respecting the arrival and departure of migrants, can only be permanently useful in proportion as they tend to throw light upon the habits and instincts of our feathered visitors, or upon the "why

and wherefore" of the phenomena of migration. During the last five years extremely little difference has occurred in the arrival of summer migrants. Taking the nightingale as a type of the rest, I find that the time of its arrival has varied only from the 9th to the 14th of April. The swallow has not been quite so regular in its appearance, it has varied from the 1st to the 9th of April.

The very considerable increase and decrease in the number of some among our resident species, during certain periods of the year, might well claim our attention; but the subject is fraught with difficulty, because it is absolutely impossible to distinguish between residents and migrants in a mixed flight of the same species. These remarks apply especially to larks, chaffinches, thrushes, starlings, and rooks; and their periodical arrival in this country, although attributable to a large extent to ever-changing atmospheric influences, can be predicated with some degree of certainty. There are other species about which no such certainty exists. In my report for the year 1882 I alluded to the marvellous influx of jays. Prior to that year jays had become comparatively scarce, and some difficulty was experienced in obtaining a sufficient supply of their gorgeous plumage for the purposes of fly-fishing. During the autumn of 1882 the eastern and southern districts of England were almost deluged with them. "I think, Sir, it must have rained jays," said a gamekeeper to me, as he pointed out the scores and scores that he had killed. Large numbers of these birds have doubtless remained with us, and at the present moment jays are far more plentiful in our county than was the case five years ago. The same remarks apply with almost equal force to our little favourites, the gold-crests. In the months of August, September, and October, 1882, an immense immigration of these tiny birds took place over the eastern districts of England, and gold-crests have certainly been more plentiful in Hertfordshire during the past few years than they were previously. The subject is a very interesting one, but at present I must not pursue it further. I remark, in conclusion, that the term "Resident," although strictly applicable to any species always to be found within the compass of the British Isles, does not imply that the same birds are not migratory elsewhere, or that large numbers of them do not come to us from abroad and again leave us very constantly.

It will have been noticed that eight out of the twelve species now first recorded in my present paper are water-fowl, and that half of these have been taken on the Elstree Reservoir. I am much indebted to Mr. E. P. Thompson, of Elstree, for the persevering manner in which he has hunted up for me particulars respecting the capture of three of them; I am under equal obligation to Mr. Henry Lewis for assistance of a similar kind in the neighbourhood of St. Albans. Since the death of the Rev. J. Harpur Crewe, of Drayton Beauchamp, who kindly supplied me with valuable information on several occasions, I have not succeeded in obtaining a single ornithological correspondent throughout the Tring and Berkhamsted districts. This is much to be regretted; the Tring

reservoirs and the slopes of the Chilterns ought to furnish important additions to our local "bird-lore." I should warmly welcome correspondents in either of the districts I have named.

Once again, I heartily thank my numerous correspondents for their valuable assistance, and venture to solicit their continued co-operation during the coming year.

XXIV.

METEOROLOGICAL OBSERVATIONS TAKEN AT WANSFORD HOUSE, WATFORD, DURING THE YEAR 1884.

By John Hopkinson, F.L.S., F.G.S., F.R.Met.Soc.

Read at Watford, 24th March, 1885.

Longitude of station, 0° 23′ 40″ W.; Latitude, 51° 39′ 45″ N. Ground-level at thermometer-stand and rain-gauge 223 feet, and cistern of barometer 234 feet above Ordnance Datum.

No alteration having been made in any respect in 1884, for further particulars as to the station, and for information with regard to the instruments used and the method of observation, the report for 1883 may be referred to. The monthly means of the daily observations in 1884, and other results, are given in the tables (pp. 220, 221), and from these (for Dec. 1883 from the previous report) the following summary for the different seasons is deduced, results for Greenwich Observatory being added for comparison as usual:

Means for the Seasons from Dec. 1883 to Nov. 1884, at Watford.

Seasons, 1883–84.	Pressure.	Temperature.		Tension of Vapour.	Humidity.	Rainfall.		Cloud 0–10.
		Mean.	Daily Range.			Total.	Days.	
	ins.	°	°	in.	%	ins.		
Winter	30·064	41·3	9·0	·227	89	5·41	47	7·3
Spring	29·924	47·4	17·5	·251	75	3·95	33	6·9
Summer.....	29·997	62·3	19·7	·426	73	5·98	35	6·0
Autumn.....	30·099	49·6	14·3	·302	84	4·86	36	6·1

The same at Greenwich.

Seasons, 1883–84.	Pressure.	Temperature.		Tension of Vapour.	Humidity.	Rainfall.		Cloud 0–10.
		Mean.	Daily Range.			Total.	Days.	
	ins.	°	°	in.	%	ins.		
Winter	30·059	42·1	9·2	·232	86	4·10	43	7·7
Spring	29·918	48·0	18·1	·256	77	3·44	36	6·6
Summer.....	29·991	62·2	22·7	·406	73	4·68	32	6·1
Autumn.....	30·078	50·2	14·5	·308	83	4·12	36	6·4

The year 1884 is the first since 1874 in which the rainfall has not been excessive, and in this most important respect it therefore presents a favourable contrast to any of the previous nine years.

Results of Meteorological Observations taken at Wansford House, Watford, in 1884.

Months.	Pressure of the Atmosphere.	Temperature of the Air.										Humidity of the Air.		
		9 a.m.	Means of		Adopted Mean.	Mean Daily Range.	Absolute Min. and Max.				Absolute Range.	Dryness.	Tension of Vapour.	Relative Humidity.
			Min.	Max.			Min.	Date.	Max.	Date.				
	ins.	°	°	°	°	°	°		°		°	°	in.	%
January	30·067	42·7	38·8	47·5	43·0	8·7	31·6	1st	53·8	30th	22·2	3·1	·243	89
February	29·938	40·7	36·1	46·7	41·2	10·6	27·3	3rd	54·0	13th	26·7	3·4	·223	88
March	29·946	42·6	36·3	51·4	43·4	15·1	26·1	3rd	67·8	16th	41·7	4·5	·230	84
April	29·845	46·0	36·0	52·0	44·7	16·0	23·7	23rd	67·5	2nd	43·8	7·5	·233	75
May	29·982	55·4	42·8	64·1	54·1	21·3	33·2	1st	81·0	24th	47·8	11·3	·289	66
June	30·051	58·3	49·0	67·2	58·2	18·2	36·2	1st	80·6	27th	44·4	8·3	·361	74
July	29·961	64·5	53·2	72·0	63·2	18·8	41·1	26th	84·8	4th	43·7	8·5	·449	74
August	29·980	67·0	53·8	76·0	65·6	22·2	44·5	5th	90·0	11th	45·4	9·8	·469	71
September	30·033	58·4	51·1	68·2	59·2	17·1	36·3	30th	82·8	17th	46·5	5·5	·401	82
October	30·088	47·9	40·5	55·9	48·1	15·4	29·4	29th	62·4	16th	33·0	4·8	·278	83
November	30·177	41·1	36·5	46·9	41·5	10·4	25·1	30th	58·9	2nd	33·8	3·4	·226	88
December	29·869	39·5	35·6	44·2	39·8	8·6	25·9	31st	53·9	7th	28·0	3·2	·214	88
Year	29·995	50·3	42·5	57·7	50·2	15·2	23·7	Apl. 23	90·0	Aug. 11	66·3	6·1	·301	80

RESULTS OF METEOROLOGICAL OBSERVATIONS TAKEN AT WANSFORD HOUSE, WATFORD, IN 1884—(*continued*).

MONTHS.	RAINFALL.					CLOUD.			WIND.									
	Total Fall.	Max. fall in 24 hours.		No. of days of		Mean Amount 0–10.	No. of days of		Mean Force 0–12.	Number of days of								
	Ins.	Ins.	Date.	Rain or Snow.	Snow only.		Clear Sky.	Overcast.		N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Calm.
January	2·90	·60	26th	15	2	7·4	4	17	2·5	0	2	0	3	1	14	4	4	3
February	1·29	·20	22nd	14	0	6·5	3	9	1·9	2	3	2	3	7	7	1	2	2
March	1·96	·79	3rd	11	0	7·0	4	13	1·6	6	4	2	2	2	6	2	2	5
April	1·34	·44	6th	13	0	7·2	5	9	1·5	2	7	2	6	3	4	1	2	3
May	·65	·16	2nd	9	0	6·5	5	7	1·9	1	8	2	3	1	7	3	3	3
June	2·39	1·10	6th	8	0	6·3	6	10	1·4	10	9	1	1	1	0	1	7	0
July	2·44	·45	6th	17	0	7·0	3	6	1·2	2	3	0	4	4	7	4	2	5
August	1·15	·27	27th	10	0	4·8	11	4	1·4	2	3	5	3	1	5	3	6	2
September	1·45	·60	3rd	12	0	5·6	7	9	1·9	1	6	5	3	3	3	1	6	2
October	1·15	·45	9th	12	1	5·8	6	10	2·1	3	5	1	2	0	4	0	12	4
November	2·26	·75	30th	12	3	6·8	5	14	1·3	2	9	2	5	1	2	0	6	3
December	3·37	·50	14th	19	2	7·4	3	16	2·6	2	5	1	2	2	10	4	2	3
Year	22·35	1·10	June 6	152	8	6·5	62	124	1·8	33	64	23	37	26	69	24	54	35

The number of rainy days was also unusually small. From 1875 to 1883 the rainfall and number of rainy days at Watford has been as follows:—

	ins.	days.		ins.	days.		ins.	days.
1875*	30·44	171	1878	34·27	190	1881	30·15	185
1876	30·05	195	1879	35·98	193	1882	33·57	199
1877	32·31	207	1880	33·35	162	1883	28·27	183

The mean for these nine years will be found to be 32·04 ins. falling on 187 days. The fall for 1884 being 22·35 ins. on 152 days, is therefore about 30 per cent. (30·3) less than the previous nine-year mean, and the number of rainy days nearly 20 per cent. (18·8) less.

The weather in 1884 was not only exceptionally dry, but also unusually warm, and the atmosphere was rather dry and bright, and not so windy as usual. Owing to there having been no very low minimum temperature, the extreme range was not great, but the mean daily range was larger than usual.

Difference in 1884 from means of 1878–82, at Watford.

Months.	Pressure.	Temperature.		Tension of Vapour.	Humidity.	Rainfall.		Cloud 0–10.
		Mean.	Daily Range.			Total.	Days.	
	in.	°	°	in.	%	ins.		
January	—·110	+8·9	—1·0	+·069	+1	+1·18	+ 3	—0·1
February	—·011	+1·9	+0·2	+·011	—1	—1·66	— 4	—1·5
March	—·078	+0·9	—0·5	+·013	+3	+0·50	— 2	+0·8
April	—·005	—1·3	—0·2	—·012	—3	—1·43	— 3	+1·2
May	—·031	+1·3	+3·0	—·011	—6	—1·69	— 5	+0·4
June	+·133	+0·3	+2·0	—·011	—1	—1·55	—11	—0·9
July	+·034	+2·1	+2·4	+·042	—1	—0·39	=	+0·4
August	+·097	+5·0	+8·0	+·044	—9	—2·51	— 5	—2·6
September	+·066	+2·4	+0·9	+·012	—2	—1·38	— 1	—0·8
October	+·156	+0·5	+2·3	—·013	—5	—2·35	— 5	—0·8
November	+·246	=	—1·3	—·003	+1	—0·43	— 4	+0·6
December	—·058	+3·6	—2·0	+·020	—3	+0·60	+ 3	+0·2
Year	+·037	+2·2	+1·1	+·013	—2	—11·11	—34	—0·3

Compared with the previous year, in 1884 the mean temperature was 1°·4 higher, the relative humidity 1 per cent. less, and the rainfall about 6 inches less. Rain (or snow) fell on 31 days less in 1884 than in 1883, and snow (only) on 7 days less. The sky was much less frequently completely overcast and rather more frequently clear of cloud. The estimated force of the wind was about the same in both years. The mean daily range of temperature was rather greater in 1884 than in 1883, and the absolute range was considerably greater, owing to the high maximum in August.

* This is Mr. Harrison's record at Oaklands, my own record commencing with the year 1876.

In the winter of 1883–84 (Dec. to Feb.) the mean pressure of the atmosphere was about the average, the mean temperature was excessively high, and the relative humidity and rainfall were about the average. In the spring (March to May) the mean pressure, mean temperature, and relative humidity were about the average, and the rainfall was considerably below it. In the summer (June to Aug.) the mean pressure and mean temperature were high, the mean daily range of temperature being very great (chiefly due to cool nights and very hot days in August), the relative humidity was low (due to the dryness of the air in August), and the rainfall was very small. In the autumn (Sept. to Nov.) the mean pressure was very high, the mean temperature rather high, the relative humidity rather low, and the rainfall, as in summer, very small.

DIFFERENCE IN 1883-84 FROM MEANS OF 1877-82, AT WATFORD.

Seasons, 1883–84.	Pressure.	Temperature.		Tension of Vapour.	Humidity.	Rainfall.		Cloud 0–10.
		Mean.	Daily Range.			Total.	Days.	
	ins.	°	°	in.	%	ins.		
Winter	+·020	+4·8	−1·3	+·033	=	−1·54	+ 1	−0·2
Spring	−·038	+0·1	+0·8	−·003	− 2	−2·62	− 8	+0·8
Summer.....	+·088	+2·4	+4·1	+·024	− 4	−4·25	−16	−1·1
Autumn.....	+·157	+1·2	+0·6	−·001	− 2	−4·16	−11	−0·6

The following notes record the general character of the weather in each month, and its principal changes.

JANUARY.—Excessively mild, rather dull, with a humid atmosphere of nearly average pressure, and with a considerable amount of rain. This was the mildest January for many years, the mean and also the absolute minimum temperature being excessively high. The minimum was in fact below 32° on 1 day only (1st), while in February the number was 5, in March 6, and in April 6. The maximum was above 42° on the very large number of 29 days, the two days on which it was not so being the 1st (37°·5) and the 27th (41°·0), and on 4 days it was above 52°. For ten days (12th to 21st) no rain fell, and during this period barometric pressure was very high, the mean being 30·544 ins., and the range from 30·380 to 30·668. Before this period 0·68 in. of rain fell, and after it 2·22 ins. During this latter (wet) period there were gales of wind, with snow and hail (26th), and barometric pressure was very low, the mean from 23rd to 31st being 29·612 ins., and the following pressures occurring on 26th and 27th:—26th, 9 a.m. 29·279, 7 p.m. 28·531, 9 p.m. 28·589, 11 p.m. 28·670; 27th, 9 a.m. 29·093.

FEBRUARY.—Very mild, rather bright and windy, with an atmosphere of average pressure and humidity, and with a small amount of rain. There was nothing in the weather of this month, except its warm temperature, which calls for special remark, and in this

respect it was not nearly so abnormal as January, the mean temp. being lower than in that month, and the 9 a.m. and mean min. considerably lower. Max. above 42° on 24 days, above 52° on 3; min. below 32° on 5. The wind was southerly (S.E. to S.W.) almost without exception from 1st to 22nd, and northerly (N.E. to N.W.) from 22nd to 29th.

March.—Warm, rather dull, and calm, with an atmosphere of average pressure and humidity, and an average amount of rain. While January was remarkable for its high minimum temperature, March was just as much so for its high maximum, 67°·8, being higher than that of April. The warmest period was from the 13th to the 20th.

1st to 12th.....	9 a.m.	38°·8	Mean Min.	33°·4	Mean Max.	47°·9	Mean	40°·0
13th to 20th.....	,,	50 ·0	,,	41 ·9	,,	60 ·8	,,	50 ·9
21st to 31st.....	,,	41 ·0	,,	35 ·4	,,	48 ·4	,,	41 ·6

Max. temp. above 52° on 12 days, above 62° on 3; min. below 32° on 6. Of the small amount of rain in the month, nearly half, 0·93 in., fell on 3rd and 4th together; from 11th to 18th only 0·01 fell, and from 22nd to 31st only 0·03 in.

April.—Cold, rather dull, and calm, with a dry atmosphere of average pressure, and a small amount of rain. This was the only cold month in the year, and the coldest April for many years. Its absolute minimum was particularly low, being 8° less than that of January. Max. above 52° on 13 days, above 62° on 2; min. below 42° on 22, below 32° on 6. The first nine days were much warmer than the rest of the month.

1st to 9th.....	9 a.m.	51°·7	Mean Min.	44°·4	Mean Max.	60°·1	Mean	52°·1
10th to 30th.....	,,	42 ·7	,,	33 ·3	,,	50 ·0	,,	42 ·0
Difference.....	,,	9 ·0	,,	11 ·1	,,	10 ·1	,,	10 ·1

The mean temperature of the last 21 days was thus 1° lower than that of the whole of January. Another marked feature in the month, to which the low temperature was doubtless in great part due, is the prevalence of northerly and north-easterly winds. For the first three days of the cold period (10th to 12th) the wind was N., and for the next 13 days (13th to 25th) it was persistently N.E. No rain fell from the 16th to the 25th (10 days).

May.—Warm, rather bright, and windy, with a very dry atmosphere of average pressure, and an exceedingly small amount of rain, much less than in any other month in the year, and in any May for many years. Although the weather was generally warm, the first seven days were rather cold, being a continuation of the cold period which prevailed during the greater part of April.

1st to 7th	9 a.m.	51°·0	Mean Min.	38°·8	Mean Max.	56°·0	Mean	48°·3
8th to 31st	,,	56 ·5	,,	42 ·6	,,	66 ·8	,,	55 ·3

Max. temp. above 62° on 19 days, above 72° on 4; min. below 42° on 11. Rain fell every day during the colder period (1st to 7th), and during the warmer period (8th to 31st) there were only two days on which any fell, 12th (0·02 in.) and 14th (0·04 in.).

From the 15th there were therefore 17 days without rain, and if we add the first 3 days of June, we have the very long period of 20 days without, and of 27 with only 0·06 in. There was a thunderstorm on the 6th. At 4 p.m. on 11th the dry-bulb thermometer stood at 76°·2, and the wet-bulb at 52°·0, giving a relative humidity of only 29 per cent.

June.—Of average temperature, rather dull, and very calm, with an atmosphere of average humidity and high pressure, and with a small amount of rain, falling on an exceptionally small number of days. As there was in May a period of 17 days without rain (20 with the first three days of June), so in June there was a period of 19 days practically without, the only fall from 10th to 28th being 0·01 in. on 22nd. On 5th and 6th together nearly 2 inches fell. The last week was warmer than the rest of the month.

1st to 23rd	9 a.m.	56°·6	Mean Min.	48°·2	Mean Max.	65°·1	Mean	56°·6
24th to 30th	,,	65 ·0	,,	51 ·4	,,	75 ·3	,,	63 ·9

The difference is chiefly in the max. temperature, which on every day during the last week exceeded 70°, and on only two days before then, 12th (73°·8) and 13th (79°·0), the mean temp. of these two days being 64°·0, about the mean of the last week. Max. temp. above 62° on 25 days, above 72° on 7 ; min. below 52° on 22, below 42° on 1 (1st). There was a great prevalence of northerly winds.

July.—Warm, rather dull, and very calm, with a rather dry atmosphere of average pressure, and with an average amount of rain. Max. temp. above 72° on 12 days, above 82° on 2 (4th and 8th); min. below 52° on 10, below 42° on 1 (26th). July is remarkable for a series of severe thunderstorms, which lasted throughout the greater part of the month. They were experienced at Watford on the 6th (with 0·45 in. of rain), 9th (with 0·10 in.), and 27th (with 0·40 in.), and on several other days thunder was heard. In Symons' 'Monthly Meteorological Magazine' (vol. xix, p. 118) the effects of the storm of the 9th at Baldock, Bygrave, Hitchin, and Stevenage are recorded. At Fairfield, near Hitchin, 2·75 ins. of rain fell between 1·30 and 3 p.m.

August.—Exceedingly warm, bright, and calm, with a dry atmosphere of rather high pressure, and a very small amount of rain. This was the hottest August for many years, but the mean temperature is considerably reduced by the comparative coldness of the last week.

1st to 24th	9 a.m.	69°·2	Mean Max.	79°·7	Mean Min.	55°·4	Mean	68°·1
25th to 31st	,,	59 ·4	,,	64 ·9	,,	51 ·8	,,	58 ·7
Difference	,,	9 ·8	,,	14 ·8	,,	3 ·6	,,	9 ·4

Max. temp. above 62° every day but 26th and 27th, above 72° on 22 days (all before 25th, the exceptions up to this time being on 4th and 19th, on each of which days it reached 71°), above 82° on 6 days (7th, 8th, 9th, 11th, 23rd, and 24th) ; min. below 52° on 9.

September.—Very warm and bright, with an atmosphere of average humidity and rather high pressure, and with a small

amount of rain. The comparatively cool and decidedly wet period which commenced on the 25th of August lasted until the 8th of September, when the weather became warm and dry. On the 22nd there was again a change to cooler weather.

1st to 8th	9 a.m.	57°·2	Mean Min.	50°·6	Mean Max.	64°·1	Mean	57°·3
9th to 21st	,,	62 ·1	,,	55 ·0	,,	74 ·1	,,	63 ·7
22nd to 30th	,,	53 ·7	,,	45 ·4	,,	63 ·7	,,	54 ·3

Rain fell on 6 of the first 8 days to the amount of 1·22 in.; on 2 of the next 13 (0·10 in.); and on 4 of the last 9 (0·13 in.). Max. temp. above 62° on 26 days, above 72° on 8 (all during warm period), above 82° on 1 (17th); min. below 42° on 1 (30th).

October.—Rather cold, moderately bright, and very windy, with a very dry atmosphere of high pressure, and with a very small amount of rain. For the first week there was no appreciable amount of rain, the only fall being 0·01 in. on 2nd; the next week was very wet, rain falling every day (8th to 14th) to the total amount of 0·89 in., and during this period there was the first fall of snow of the winter, at 1·30 p.m. on 10th; for the next 10 days (15th to 24th) there was no rain; and during the last week 0·25 in. fell, on 4 days. Max. temp. above 52° on 26 days, above 62° on 1 (16th); min. below 42° on 15, below 32° on 3 (5th, 25th, and 29th).

November.—Of average temperature, dull, and very calm, with a somewhat humid atmosphere of unusually high pressure, and less than the average amount of rain; the tenth dry month in succession. For the first 10 days the weather was warm and wet, for the remainder of the month it was cold and with scarcely any rain except on the 30th.

1st to 10th	9 a.m.	49°·0	Mean Min.	41°·6	Mean Max.	55°·5	Mean	48°·7
11th to 30th	,,	37 ·6	,,	34 ·2	,,	42 ·6	,,	38 ·1
Difference	,,	11 ·4	,,	7 ·4	,,	12 ·9	,,	10 ·6

From 1st to 10th 1·41 in. of rain fell on 6 days; from 11th to 29th 0·10 in. fell on 4 days (0·09 in. 18th to 21st, and 0·01 in. 28th); and on 30th there was a storm of snow and rain yielding 0·75 in. of rain, being about one-third the total fall of the month. Max. temp. above 52° on 9 days; min. below 32° on 5.

December.—Very mild, dull, and rather windy, with a dry atmosphere of rather low pressure, and with a considerable amount of rain. From the 1st to the 25th there were not any two days in succession without rain, but after the 25th no rain fell; including the last day of November there was thus a period of 26 days on 20 of which rain (and snow) fell to the total amount of 4·12 ins. Max. temp. above 42° on 17 days (all before 21st), above 52° on 5 (all during the first week, except one, 13th); min. below 32° on 6. The temperature was very variable, the first two days being cold, from 3rd to 15th warm, 16th to 20th colder, and 21st to 31st colder still.

XXV.

REPORT ON PHENOLOGICAL PHENOMENA OBSERVED IN HERTFORDSHIRE DURING THE YEAR 1884.

By John Hopkinson, F.L.S., F.G.S., etc.

Read at Watford, 24th March, 1885.

The systematic observation of Phenological Phenomena, which in 1875 received considerable impetus in this country from the scheme then formulated by the Meteorological Society of London and adopted by our Society,* is now attracting considerable attention on the Continent of Europe. Drs. Egon Ihne and Hermann Hoffmann have recently published a work on the subject,† the first part of which, by Dr. Ihne, is a History of Phenological Observations in Europe, with a catalogue of the publications in which they are given, and the second, by Dr. Hoffmann, Phenological Observations made [in Germany] in the years 1879–82. Dr. Ihne, in his Introduction, says that in 1882 he resolved to commence the work of drawing up a Phenological Map of Europe. He soon found that materials were plentiful, but dispersed in many publications, the titles of which did not indicate that they contained phenological observations. This induced him to make a catalogue of all publications on phenological phenomena, and a complete list of the works in which they are contained. He was astonished at the abundance of the observations which for more than 100 years have been made in all parts of Europe. For every country he gives a brief survey of the history of phenological observations, and a list of the works on the subject arranged in chronological order.

The earliest phenological observations recorded by Dr. Ihne are those made in this country by Marsham, who commenced to observe the dates of flowering of plants in the year 1735 at Stratton in Suffolk, and published his "Indications of Spring" in the 'Transactions of the Royal Society' in 1789. Stillingfleet's observations made at Stratton in 1755 are, however, catalogued first, having been published in his 'Miscellaneous Tracts relating to Natural History' in 1762. Amongst the most recent observations those made by the members of our Society are duly referred to. As an illustration of the thoroughness of Dr. Ihne's work, and its value to those who wish to know what has been done for any particular locality, I may mention that 315 places in Great Britain where phenological observations have been made are enumerated, the index giving the years of observation at each place (to 1882) and reference-numbers to the publications in which the observations are to be found. The following localities in Hertfordshire are thus indexed, with a reference-number to the notice which is given (on pp. 98, 99) of my own annual reports in the 'Transactions' of our Society, and to the notice of the Rev. T. A. Preston's reports in

* See 'Trans. Watford Nat. Hist. Soc.,' Vol. I, Part 2, p. 33.

† 'Beiträge zur Phänologie.' 8vo. Giessen, 1884.

the 'Quarterly Journal of the Meteorological Society,' when the returns of our observers have also been tabulated there.

St. Albans, 1878–82.	Hunton Bridge, 1881.
Berkhamsted, 1880, 81.	Odsey, 1877–81.
Hailey Hall, 1881.	Redbourn, 1878.
Harpenden, 1878–82.	Royston, 1882.
Hertford, 1878–82.	Sawbridgeworth, 1879–82.
High Wych, 1880–82.	Throcking, 1880, 81.
Hoddesdon, 1880–82.	Ware, 1876–82.
Hormead, 1880, 81.	Watford, 1875–82.

In Dr. Hoffmann's contribution to this work a list is given of about 40 species of plants (chiefly trees or shrubs) of which one or more of the following particulars should be noted:—(*a*) first leaf-surface visible or first leaf extended, (*b*) first flower open, (*c*) first fruit ripe, and (*d*) general colouring of the leaf. The following species in Dr. Hoffmann's list are also in our own, and to these I would therefore urge our observers to pay special attention:—

20. *Æsculus Hippocastanum* (horse chestnut): *a*, *b*, *c*, *d*.*
21. *Cytisus Laburnum* (laburnum): *b*.
27. *Prunus spinosa* (blackthorn or sloe): *b*.
32. *Cratægus Oxyacantha* (hawthorn): *b*.
38. *Cornus sanguinea* (dog-wood): *b*, *c*.
39. *Syringa vulgaris* (lilac): *b*.
56. *Ligustrum vulgare* (privet): *b*, *c*.
73. *Fagus sylvatica* (beech): *a*, *d*.
74. *Corylus Avellana* (hazel): *b*.

I will now proceed with the report of our own observations in 1884.

There is no change this year to report in the staff of our regular observers of phenological phenomena, and therefore our principal table showing the dates of flowering of plants comprises returns from the same eight stations as in the report for 1883. These stations, with their latitudes and longitudes, and the names of the observers, are as follows:—

Station.	N. Lat.	Long.	Observer.
Watford	51 39	0 24w	Mrs. J. Hopkinson.
Harpenden	51 48½	0 21w	Mr. J. J. Willis.
Hertford	51 48	0 5w	Mr. R. T. Andrews.
Ware (Fanhams Hall)	51 49	0 1w	Major R. B. Croft.
High Wych, Sawbridgeworth	51 48⅓	0 8E	Miss Simpson.
Hitchin	51 57	0 16w	Natural Hist. Club.†
Odsey	52 1½	0 7w	Mr. H. G. Fordham.
Royston	52 2	0 1w	Mr. A. Kingston.

The observations made at these stations are recorded in the accompanying table, in which there is also a column giving the mean dates for the period of our register, 1876–84, several of the species having, however, only been observed a few years out of the nine.

* These letters denote the observation to be made as indicated above.
† Communicated by Mr. W. Hill, jun.

Dates of Flowering of Plants observed in 1884, with the Mean Date for 1876–84.

No.	Species.	Watford.	Harpenden.	Hertford.	Ware.	High Wych.	Hitchin.	Odsey.	Royston.	Mean.
1.	*Anemone nemorosa*	Mar. 10	Mar. 1	Mar. 7	Mar. 14	.....	.....	.....	.....	Mar. 11
2.	*Ranunculus Ficaria*	Feb. 4	Mar. 1	Feb. 5	Feb. 1	.....	.....	.....	Jan. 28	Feb. 17
3.	*Ranunculus acris*	.....	Apl. 10	Apl. 10	.....	.....	Apl. 10	.....	May 3	Apl. 21
4.	*Caltha palustris*	Mar. 30	Apl. 1	Apl. 5	Apl. 7	Mar. 24	.....	.....	Mar. 20	Mar. 20
5.	*Papaver Rhœas*	May 28	May 19	May 19	.....	.....	June 7	.....	May 22	May 28
6.	*Nasturtium officinale*	.....	May 24	May 21	.....	June 7	.....	.....	.....	June 3
7.	*Cardamine pratensis*	Apl. 6	Apl. 6	Apl. 5	Apl. 7	.....	Apl. 7	.....	Apl. 9	Apl. 12
8.	*Sisymbrium Alliaria*	Apl. 3	Apl. 18	Apl. 5	.....	.....	.....	.....	Apl. 8	Apl. 9
9.	*Draba verna*	.....	Mar. 6	Feb. 18	.....	.....	.....	.....	Feb. 29	Mar. 4
10.	*Viola odorata*	.....	.....	.....	.....	.....	.....	.....	Jan. 20	Feb. 9
11.	*Polygala vulgaris*	May 18	June 8	May 26	.....	.....	May 16	.....	May 8	May 5
12.	*Lychnis Flos-cuculi*	.....	May 18	May 26	.....	May 26	May 17	.....	.....	May 24
13.	*Stellaria Holostea*	Mar. 23	Mar. 15	Mar. 22	Mar. 30	Apl. 12	Apl. 2	.....	Mar. 25	Apl. 2
14.	*Malva sylvestris*	June 7	.....	.....	June 14	June 6	June 6	.....	June 5	June 5
15.	*Hypericum tetrapterum*	.....	.....	June 29	.....	.....	.....	.....	.....	July 2
16.	*Hypericum pulchrum*	.....	June 29	June 28	.....	.....	June 20	.....	June 28	June 28
17.	*Geranium Robertianum*	Mar. 17	Apl. 19	May 1	Apl. 25	Apl. 20	Apl. 6	.....	May 15	Apl. 24
18.	*Euonymus europæus*	May 19	May 18	May 28	.....	.....	.....	.....	.....	May 27
19.	*Acer Pseudo-platanus*	.....	.....	Apl. 11	.....	May 12	.....	.....	.....	Apl. 11
20.	*Æsculus Hippocastanum*	.....	May 16	Apl. 11	.....	May 20	.....	.....	May 13	Apl. 30
21.	*Cytisus Laburnum*	May 7	May 24	May 13	.....	May 20	.....	.....	May 11	May 13
22.	*Trifolium repens*	May 18	May 12	.....	May 26	May 25	May 26	.....	May 22	May 17
23.	*Lotus corniculatus*	May 22	May 24	May 22	May 26	May 24	May 20	.....	May 15	May 19
24.	*Vicia Cracca*	.....	June 24	June 16	.....	June 27	June 30	.....	.....	June 24
25.	*Vicia sepium*	Apl. 30	Apl. 29	Apl. 9	May 10	May 11	Apl. 26	.....	May 2	Apl. 26
26.	*Lathyrus pratensis*	.....	June 4	May 27	June 14	May 30	June 4	.....	June 6	June 3
27.	*Prunus spinosa*	Mar. 17	Mar. 18	.....	Mar. 16	Mar. 24	.....	Mar. 17	Mar. 15	Mar. 22
28.	*Spiræa Ulmaria*	June 15	June 20	June 24	.....	June 20	June 21	.....	June 22	June 15
29.	*Potentilla anserina*	May 18	May 25	May 21	May 22	May 25	May 16	.....	May 18	May 15
30.	*Rosa canina*	June 1	May 30	May 26	May 26	June 9	June 3	June 7	June 4	June 2
31.	*Pyrus Aucuparia*	May 10	May 11	May 24	.....	.....	.....	.....	May 5	May 15
32.	*Cratægus Oxyacantha*	May 7	May 2	.....	.....	May 5	.....	.....	May 2	May 10
33.	*Epilobium hirsutum*	.....	June 19	June 29	.....	July 4	July 8	.....	.....	July 6
34.	*Epilobium montanum*	June 22	June 13	June 10	.....	June 16	June 30	.....	.....	June 10
35.	*Angelica sylvestris*	.....	.....	Aug. 1	.....	.....	.....	.....	.....	July 30
36.	*Daucus Carota*	.....	.....	.....	.....	.....	.....	.....	.....	.....

39.	*Syringa vulgaris*	.....	May 2	.....	.....	.....	.....	.....	.....		May 10
40.	*Galium Aparine*	May 18	May 16	May 17	May 23	May 12	May 11	.....	May 16	May 15	
41.	*Galium verum*	.....	June 13	June 19	.....	July 8	June 30	.....	.....	June 28	
42.	*Dipsacus sylvestris*	.....	.....	Aug. 1	.....	.....	.....	.....	.....	July 25	
43.	*Scabiosa succisa*	.....	.....	Aug. 1	.....	.....	.....	.....	.....	July 25	
44.	*Petasites vulgaris*	.....	.....	Mar. 6	.....	.....	.....	.....	.....	Mar. 16	
45.	*Tussilago Farfara*	Feb. 17	Feb. 26	Feb. 7	.....	.....	.....	Feb. 10	Feb. 12	Feb. 22	
46.	*Achillea Millefolium*	June 22	June 25	June 21	.....	June 27	.....	.....	June 30	June 23	
47.	*Chrysanthemum Leucanthemum*	May 20	May 11	May 19	May 26	May 20	May 19	.....	May 11	May 17	
48.	*Artemisia vulgaris*	.....	.....	Aug. 6	.....	Aug. 1	July 20	.....	.....	Aug. 1	
49.	*Senecio Jacobæa*	.....	.....	July 1	.....	July 11	.....	.....	.....	June 30	
50.	*Centauria nigra*	June 15	.....	June 14	.....	July 6	June 12	.....	June 19	June 19	
51.	*Carduus lanceolatus*	.....	June 14	June 20	.....	.....	June 21	.....	.....	June 17	
52.	*Carduus arvensis*	.....	.....	June 28	.....	.....	June 10	.....	.....	June 16	
53.	*Sonchus arvensis*	July 5	.....	July 4	.....	July 6	July 6	.....	.....	July 8	
54.	*Hieracium Pilosella*	.....	May 29	May 12	.....	June 15	May 13	.....	May 18	May 15	
55.	*Campanula rotundifolia*	.....	.....	July 11	.....	.....	July 12	.....	.....	July 8	
56.	*Ligustrum vulgare*	June 23	.....	June 17	.....	June 23	.....	.....	.....	June 18	
57.	*Convolvulus sepium*	July 6	.....	July 3	.....	July 3	July 5	.....	.....	July 10	
58.	*Symphytum officinale*	.....	May 9	.....	May 3	May 26	May 14	.....	.....	May 6	
59.	*Pedicularis sylvatica*	.....	.....	Apl. 28	.....	.....	.....	.....	.....	May 10	
60.	*Veronica Chamædrys*	Apl. 20	Apl. 29	Apl. 16	.....	Apl. 22	Apl. 23	.....	May 3	Apl. 21	
61.	*Mentha aquatica*	.....	.....	Aug. 1	.....	Aug. 2	July 17	.....	.....	July 28	
62.	*Thymus Serpyllum*	June 3	June 13	.....	.....	.....	June 9	.....	June 7	June 7	
63.	*Prunella vulgaris*	.....	June 17	June 23	.....	.....	June 20	.....	.....	June 18	
64.	*Nepeta Glechoma*	Mar. 17	Mar. 16	.....	Mar. 26	Mar. 17	.....	Mar. 30	Mar. 25	Mar. 24	
65.	*Galeopsis Tetrahit*	.....	.....	.....	.....	.....	June 20	.....	.....	June 26	
66.	*Stachys sylvatica*	June 17	June 11	June 8	.....	June 6	.....	.....	.....	June 6	
67.	*Ajuga reptans*	May 6	May 12	May 1	Apl. 29	May 7	May 15	.....	May 5	May 3	
68.	*Primula veris*	Mar. 5	Mar. 10	Mar. 19	Mar. 26	Mar. 24	Mar. 25	Mar. 25	Mar. 26	Mar. 16	
69.	*Plantago lanceolata*	.....	Apl. 22	Apl. 7	Apl. 25	.....	Apl. 9	.....	May 7	Apl. 20	
70.	*Mercurialis perennis*	Feb. 3	Jan. 28	Jan. 30	Feb. 8	.....	.....	.....	Jan. 26	Feb. 13	
71.	*Ulmus montana*	.....	Feb. 14	Feb. 14	.....	.....	.....	Feb. 13	Feb. 24	Feb. 27	
72.	*Salix Caprea*	Feb. 25	Mar. 12	Mar. 3	Mar. 7	.....	.....	.....	Mar. 5	Mar. 5	
73.	*Fagus sylvatica*	.....	.....	May 19	.....	.....	.....	.....	.....	.....	
74.	*Corylus Avellana*	Jan. 15	Jan. 23	Jan. 7	Jan. 10	Jan. 15	.....	Jan. 27	Jan. 12	Jan. 24	
75.	*Orchis maculata*	June 7	May 20	May 21	.....	.....	.....	.....	June 3	June 2	
76.	*Iris Pseud-acorus*	.....	June 11	June 14	May 28	June 13	June 12	.....	.....	June 3	
77.	*Narcissus Pseudo-narcissus*	Feb. 25	Mar. 12	Mar. 9	Feb. 23	.....	.....	Feb. 29	.....	Mar. 3	
78.	*Galanthus nivalis*	Jan. 22	Jan. 20	Jan. 14	Jan. 20	Jan. 22	.....	Jan. 19	.....	Jan. 21	
79.	*Scilla nutans*	Mar. 30	Mar. 27	Apl. 6	Apl. 29	.....	Apl. 2	.....	Apl. 7	Apl. 12	

Dates of Flowering of Plants observed in 1884, with the Mean Date for 1876–84.

No.	Species.	Watford.	Harpenden.	Hertford.	Ware.	High Wych.	Hitchin.	Odsey.	Royston.	Mean.
1.	*Anemone nemorosa*	Mar. 10	Mar. 1	Mar. 7	Mar. 14	.....	.....	.....	.....	Mar. 11
2.	*Ranunculus Ficaria*	Feb. 4	Mar. 1	Feb. 5	Feb. 1	.....	.....	.....	Jan. 28	Feb. 17
3.	*Ranunculus acris*	.....	Apl. 10	Apl. 10	.....	.....	Apl. 10	.....	May 3	Apl. 21
4.	*Caltha palustris*	Mar. 30	Apl. 1	Apl. 5	Apl. 7	Mar. 24	.....	.....	Mar. 20	Mar. 20
5.	*Papaver Rhœas*	May 28	May 19	May 19	.....	.....	June 7	.....	May 22	May 28
6.	*Nasturtium officinale*	.....	May 24	May 21	.....	June 7	.....	.....	.....	June 3
7.	*Cardamine pratensis*	Apl. 6	Apl. 6	Apl. 5	Apl. 7	.....	Apl. 7	.....	Apl. 9	Apl. 12
8.	*Sisymbrium Alliaria*	Apl. 3	Apl. 18	Apl. 5	.....	.....	.....	.....	Apl. 8	Apl. 9
9.	*Draba verna*	.....	Mar. 6	Feb. 18	.....	.....	.....	.....	Feb. 29	Mar. 4
10.	*Viola odorata*	.....	.....	.....	.....	.....	.....	.....	Jan. 20	Feb. 9
11.	*Polygala vulgaris*	May 18	June 8	May 26	.....	.....	May 16	.....	May 8	May 5
12.	*Lychnis Flos-cuculi*	.....	May 18	May 26	.....	May 26	May 17	.....	.....	May 24
13.	*Stellaria Holostea*	Mar. 23	Mar. 15	Mar. 22	Mar. 30	Apl. 12	Apl. 2	.....	Mar. 25	Apl. 2
14.	*Malva sylvestris*	June 7	.....	.....	June 14	June 6	June 6	.....	June 5	June 5
15.	*Hypericum tetrapterum*	.....	.....	June 29	.....	.....	.....	.....	.....	July 2
16.	*Hypericum pulchrum*	.....	June 29	June 28	.....	.....	June 20	.....	June 28	June 28
17.	*Geranium Robertianum*	Mar. 17	Apl. 19	May 1	Apl. 25	Apl. 20	Apl. 6	.....	May 15	Apl. 24
18.	*Euonymus europæus*	May 19	May 18	May 28	.....	.....	.....	.....	.....	May 27
19.	*Acer Pseudo-platanus*	.....	.....	Apl. 11	.....	May 12	.....	.....	.....	Apl. 11
20.	*Æsculus Hippocastanum*	.....	May 16	Apl. 11	.....	May 20	.....	.....	May 13	Apl. 30
21.	*Cytisus Laburnum*	May 7	May 24	May 13	.....	May 20	.....	.....	May 11	May 13
22.	*Trifolium repens*	May 18	May 12	.....	May 26	May 25	May 26	.....	May 22	May 17
23.	*Lotus corniculatus*	May 22	May 24	May 22	May 26	May 24	May 20	.....	May 15	May 19
24.	*Vicia Cracca*	.....	June 24	June 16	.....	June 27	June 30	.....	.....	June 24
25.	*Vicia sepium*	Apl. 30	Apl. 29	Apl. 9	May 10	May 11	Apl. 26	.....	May 2	Apl. 26
26.	*Lathyrus pratensis*	.....	June 4	May 27	June 14	May 30	June 4	.....	June 6	June 3
27.	*Prunus spinosa*	Mar. 17	Mar. 18	.....	Mar. 16	Mar. 24	.....	Mar. 17	Mar. 15	Mar. 22
28.	*Spiræa Ulmaria*	June 15	June 20	June 24	.....	June 20	June 21	.....	June 22	June 15
29.	*Potentilla anserina*	May 18	May 25	May 21	May 22	May 25	May 16	.....	May 18	May 15
30.	*Rosa canina*	June 1	May 30	May 26	May 26	June 9	June 3	June 7	June 4	June 2
31.	*Pyrus Aucuparia*	May 10	May 11	May 24	.....	.....	.....	.....	May 5	May 15
32.	*Cratægus Oxyacantha*	May 7	May 2	.....	.....	May 5	.....	.....	May 2	May 10
33.	*Epilobium hirsutum*	.....	June 19	June 29	.....	July 4	July 8	.....	.....	July 6
34.	*Epilobium montanum*	June 22	June 13	June 10	.....	June 16	June 30	.....	.....	June 10
35.	*Angelica sylvestris*	.....	.....	Aug. 1	.....	.....	.....	.....	.....	July 30
36.	*Daucus Carota*	.....	.....	.....	.....	.....	.....	.....	.....	.....
37.	*Hedera Helix*	Sept. 14	.....	Sept. 12	.....	.....	Sept. 20	...	...	Sept. 25
38.	*Cornus sanguinea*	June 21	June 21	June 11	.....	.....	.....	.....	.....	June 12
39.	*Syringa vulgaris*	.....	May 2	.....	.....	.....	.....	.....	.....	May 10
40.	*Galium Aparine*	May 18	May 16	May 17	May 23	May 12	May 11	.....	May 16	May 15
41.	*Galium verum*	.....	June 13	June 19	.....	July 8	June 30	.....	.....	June 28
42.	*Dipsacus sylvestris*	.....	.....	Aug. 1	.....	.....	.....	.....	.....	July 25
43.	*Scabiosa succisa*	.....	.....	Aug. 1	.....	.....	.....	.....	.....	July 25
44.	*Petasites vulgaris*	.....	.....	Mar. 6	.....	.....	.....	.....	.....	Mar. 16
45.	*Tussilago Farfara*	Feb. 17	Feb. 26	Feb. 7	.....	.....	.....	Feb. 10	Feb. 12	Feb. 22
46.	*Achillea Millefolium*	June 22	June 25	June 21	.....	June 27	.....	.....	June 30	June 23
47.	*Chrysanthemum Leucanthemum*	May 20	May 11	May 19	May 26	May 20	May 19	.....	May 11	May 17
48.	*Artemisia vulgaris*	.....	.....	Aug. 6	.....	Aug. 1	July 20	.....	.....	Aug. 1
49.	*Senecio Jacobæa*	.....	.....	July 1	.....	July 11	.....	.....	.....	June 30
50.	*Centaurea nigra*	June 15	.....	June 14	.....	July 6	June 12	.....	June 19	June 19
51.	*Carduus lanceolatus*	.....	June 14	June 20	.....	.....	June 21	.....	.....	June 17
52.	*Carduus arvensis*	.....	.....	June 28	.....	.....	June 10	.....	.....	June 16
53.	*Sonchus arvensis*	July 5	.....	July 4	.....	July 6	July 6	.....	.....	July 8
54.	*Hieracium Pilosella*	.....	May 29	May 12	.....	June 15	May 13	.....	May 18	May 15
55.	*Campanula rotundifolia*	.....	.....	July 11	.....	.....	July 12	.....	.....	July 8
56.	*Ligustrum vulgare*	June 23	.....	June 17	.....	June 23	.....	.....	.....	June 18
57.	*Convolvulus sepium*	July 6	.....	July 3	.....	July 3	July 5	.....	.....	July 10
58.	*Symphytum officinale*	.....	May 9	...	May 3	May 26	May 14	.....	.....	May 6
59.	*Pedicularis sylvatica*	.....	.....	Apl. 28	.....	.....	.....	.....	.....	May 10
60.	*Veronica Chamædrys*	Apl. 20	Apl. 29	Apl. 16	.....	Apl. 22	Apl. 23	.....	May 3	Apl. 21
61.	*Mentha aquatica*	.....	.....	Aug. 1	.....	Aug. 2	July 17	.....	.....	July 28
62.	*Thymus Serpyllum*	June 3	June 13	....	.....	.....	June 9	.....	June 7	June 7
63.	*Prunella vulgaris*	.....	June 17	June 23	.....	.....	June 20	.....	.....	June 18
64.	*Nepeta Glechoma*	Mar. 17	Mar. 16	.....	Mar. 26	Mar. 17	.....	Mar. 30	Mar. 25	Mar. 24
65.	*Galeopsis Tetrahit*	.....	...	.....	.....	.....	June 20	.....	.....	June 26
66.	*Stachys sylvatica*	June 17	June 11	June 8	.....	June 6	.....	.....	.....	June 6
67.	*Ajuga reptans*	May 6	May 12	May 1	Apl. 29	May 7	May 15	.....	May 5	May 3
68.	*Primula veris*	Mar. 5	Mar. 10	Mar. 19	Mar. 26	Mar. 24	Mar. 25	Mar. 25	Mar. 26	Mar. 16
69.	*Plantago lanceolata*	.....	Apl. 22	Apl. 7	Apl. 25	.....	Apl. 9	.....	May 7	Apl. 20
70.	*Mercurialis perennis*	Feb. 3	Jan. 28	Jan. 30	Feb. 8	.....	.....	.....	Jan. 26	Feb. 13
71.	*Ulmus montana*	.....	Feb. 14	Feb. 14	.....	.....	.....	Feb. 13	Feb. 24	Feb. 27
72.	*Salix Caprea*	Feb. 25	Mar. 12	Mar. 3	Mar. 7	.....	.....	.....	Mar. 5	Mar. 5
73.	*Fagus sylvatica*	.....	.....	May 19	.....	.....	.....	.....	.....	.....
74.	*Corylus Avellana*	Jan. 15	Jan. 23	Jan. 7	Jan. 10	Jan. 15	.....	Jan. 27	Jan. 12	Jan. 24
75.	*Orchis maculata*	June 7	May 20	May 21	.....	.....	.....	.....	June 3	June 2
76.	*Iris Pseud-acorus*	.....	June 11	June 14	May 28	June 13	June 12	.....	.....	June 3
77.	*Narcissus Pseudo-narcissus*	Feb. 25	Mar. 12	Mar. 9	Feb. 23	.....	.....	Feb. 29	.....	Mar. 3
78.	*Galanthus nivalis*	Jan. 22	Jan. 20	Jan. 14	Jan. 20	Jan. 22	.....	Jan. 19	.....	Jan. 21
79.	*Scilla nutans*	Mar. 30	Mar. 27	Apl. 6	Apl. 29	.....	Apl. 2	.....	Apl. 7	Apl. 12

The earliest dates of observations of insects and birds alone being given in the following table, for details Mr. Silvester's notes on the insects (p. 233) and Mr. Littleboy's notes on the birds (p. 207) should be referred to.

EARLIEST DATES OF OBSERVATIONS OF INSECTS, BIRDS, ETC., IN 1884, WITH THE MEAN DATE FOR 1876–84.

No.	SPECIES.	1884.	MEAN.
80.	*Melolontha vulgaris* (cock-chafer) appears	May 22	May 25
81.	*Rhizotrogus solstitialis* (fern-chafer) ap.	May 23	June 9
82.	*Timarcha lævigata* (bloody-nosed beetle) ap.	Mar. 16	.....
83.	*Lampyris noctiluca* (glow-worm) ap.	June 12	June 15
84.	*Apis mellifica* (honey-bee) ap.	Jan. 1	Jan. 23
85.	*Vespa vulgaris* (common wasp) ap.	Mar. 27	Mar. 30
86.	*Pieris Brassicæ* (large white butterfly) ap.	Mar. 15	Apl. 9
87.	*P. Rapæ* (small white butterfly) ap.	Mar. 8	Mar. 24
88.	*Anthocaris cardamines* (orange-tip butterfly) ap.	May 17	May 1
89.	*Epinephile Janira* (meadow-brown butterfly) ap.	May 24	May 26
90.	*Bibio Marci* (St. Mark's fly) ap.	Apl. 29	Apl. 28
91.	*Strix Aluco* (brown owl) hoots	Apl. 1	Mar. 18
92.	*Muscicapa grisola* (flycatcher) arrives	May 10	May 14
	——— nests	May 30	.....
	——— hatches	June 8	.....
93.	*Turdus musicus* (song-thrush) sings	Jan. 1	Jan. 11
	——— nests	Mar. 23	.....
	——— hatches	Apl. 3	.....
94.	*T. pilaris* (field-fare) arrives	Aug. 25	Oct. 23
95.	*Daulias Luscinia* (nightingale) sg.	Apl. 7	Apl. 13
96.	*Saxicola Œnanthe* (wheatear) arr.	Mar. 30	.....
97.	*Phylloscopus Trochilus* (willow-wren) sg.	Mar. 17	Mar. 27
98.	*P. collybita* (chiff-chaff) sg.	Mar. 30	Mar. 23
99.	*Alauda arvensis* (sky-lark) sg.	Jan. 1	Jan. 15
100.	*Fringilla cœlebs* (chaffinch) sg.	.....	Feb. 4
101.	*Corvus frugilegus* (rook) builds	Feb. 25	Feb. 20
	——— hatches	Apl. 8	.....
102.	*Cuculus canorus* (cuckoo) calls	Apl. 5	Apl. 10
	——— changes its note	May 25	May 30
103.	*Hirundo rustica* (swallow) arr.	Apl. 3	Apl. 11
	——— flocks	Aug. 12	.....
	——— departs (last seen)	Oct. 20	.....
104.	*H. urbica* (house-martin) arr.	Apl. 3	Apl. 9
105.	*H. riparia* (sand-martin) arr.	Apl. 3	Apl. 10
106.	*Cypselus Apus* (swift) arr.	Apl. 28	May 7
	——— departs (last seen)	Sept. 19	.....
107.	*Caprimulgus europæus* (goatsucker) arr.	.....	.....
108.	*Columba Turtur* (turtle-dove) coos	May 9	May 2
109.	*Perdix cinerea* (partridge) pairs	Jan. 22	.....
110.	*Scolopax Rusticola* (woodcock) arr.	Sept. 1	Oct. 10
111.	*Crex pratensis* (corn-crake) arr.	Apl. 10	Apl. 22
112.	*Rana temporaria* (common frog) spawns	Feb. 12	Mar. 8

Frog spawn was first seen at Watford on the 23rd of February, at Fanhams Hall, Ware, on the 11th of March, and at Hertford on the 15th of March.

The general result of the observations of the time of flowering of plants, as recorded in the accompanying table,* is to show that 1884 may be considered a decidedly early year.

Of the 60 species mentioned in the previous report as trustworthy tests of the state of vegetation from the end of January to near the end of July, all have been observed in 1884, so that we have now mean dates for this period deduced from at least 7 years' observation of every one of these species. Of these 60 species, 49 came into flower earlier than the mean of 1876–84, only 6 later, and 5 on the same day as the mean, so that vegetation was evidently remarkably forward in 1884. The average state of forwardness over the mean of 1876–84 is 7·3 days.

Of the 30 species which come into flower by the middle of May, which we consider as spring flowers, 27 showed themselves before the mean date, 2 after it, and 1 on the same day as the mean; and of the 30 which come into flower after this time, which we consider as summer flowers, 22 showed themselves before the mean date, 3 after it, and 4 on the same day as the mean. The average state of forwardness of the spring flowers was 10·3 days, and of the summer flowers 4·3 days.

Dividing the period of observation into three, as before, the average date of the first 20 species, from 21st January to 20th April, is 12 days early; of the next 20, from 21st April to 3rd June, 6·7 days; and of the last 20, from 5th June to 25th July, 3·2 days; showing that the state of forwardness was by far the greatest in the early spring, little more than half as much towards the end of spring, and little more than one-fourth as much in the early part of summer.

Taking each 10 species which are nearly coincident in their average date of flowering with each month from February to July, there is a gradual retardation in the state of forwardness except towards the close of the period. The average for February is 13·9 days early, for March 10·0 days early, for April 7·0 days early, for May 6·5 days early, for June 2·3 days early, and for July 4·4 days early.

Of the 10 species selected to represent February, the 2 which usually come into flower within the last ten days of January averaged 12 days early; the 5 which flower in February averaged 16 days early; and the 3 which usually flower in the first week in March averaged 11 days early, all appearing within the month of February. This shows a very similar state of vegetation to that prevailing at the same time in the previous year, and is due as then to the very mild winter. At Harpenden, "owing to the unusual mildness and even temperature of January, many flowers, among

* In addition to the tabulated records the following observations have been made at Croxley Green and its vicinity (between Watford and Rickmansworth) by Mr. F. G. Lloyd:—

2.	*Ranunculus Ficaria*,	March 9	64.	*Nepeta Glechoma*,	March 17
27.	*Prunus spinosa*,	,, 16	77.	*Narcissus Pseudo-narcissus*,	,, 10
60.	*Veronica Chamædrys*,	,, 16			

which may be mentioned the violet (10), the primrose, and the stock, were very prolific in bloom. A blackthorn (27) was observed in full leaf at Rothamsted. The wheat plants and winter oats were particularly strong and healthy, with dark green foliage." At Hertford "many plants, as the dandelion, primrose, and *Veronica Buxbaumii*, had not left off flowering in January, and others, as *Anthriscus sylvestris*, were stimulated into abnormal flowering." At Royston "the cold winds which prevailed during February somewhat checked the early promise of January, and at the end of February vegetation was not so forward as might have been expected."

Of the species for March, the 6 flowering within the month averaged 8 days early, and the 4 usually flowering in April, 13 days early, two of these appearing before the end of March. The weather in February, though mild, was colder than in January, the difference being chiefly in the lower minima of February. This appears to have somewhat retarded the state of forwardness in March, until towards the close of the month, by which time the warm period prevailing between the 13th and 20th produced its natural result.

Of the species representing April, 4 which usually flower within the month averaged 13 days early, and 6 which usually flower in May only 3 days early, two of these appearing in April. The last ten days in March were cold, and very little rain fell, but the first nine in April were warm. This cold dry period in March does not appear to have produced any retarding effect upon vegetation, unless the great retardation at the end of April is due in some measure to it; but there is a more immediate cause for this in the very cold period prevailing during the last three weeks of April, the mean temperature of which was lower than that of January or March and very little higher than that of February. Our observer at Royston says that April was "an extraordinary month, with nothing to record between the opening and closing weeks. With the rain and sultry weather for a day or two at the beginning of the month vegetation went forward with leaps and bounds, only to meet with such a severe check as is fortunately not often experienced in April. In one night (18th) and in succeeding nights between 18th and 24th the frost carried everything before it, and thousands of pounds were lost to the fruit-growers in this neighbourhood (Royston). The budding horse-chestnut (20) and other trees had their leaves turned black and shrivelled up as if burnt. The appearance of the nightingale (95), cuckoo (102), and swallow (103) was delayed more than a week beyond the latest expected time, and the hawthorn (32), which would have blossomed with the arrival of the cuckoo but for this unseasonable visitation of frost, must now, except here and there in a sunny sheltered spot, be referred to the opening days of May."

For May the 6 species really coming into flower within the month averaged 6 days early, and the 4 usually flowering in the first three days of June averaged 8 days early, all of these this

year appearing in May. Here there appears to be a recovery from the retarding effect of the cold weather of April, which lasted to the close of the first week in May, when a warm, bright, and very dry period commenced. Our Royston observer says that "following the remarkable frosts and cold winds of April, this proved to be one of the warmest and driest Mays known for many years, and the severe check to vegetation was more than counterbalanced by the stimulus of the hot sunshine of May; but the horse-chestnut (20) and some other species never quite recovered from the severe effects of frost just when they had reached the budding stage."

The first 5 species for June averaged 1 day early and the next 5 species 4 days early, all flowering as usual within the month. The sudden retardation, after an average for 4 species near the end of May of 8 days early, is remarkable; for there does not appear to be anything in the weather to account for it, June having an average temperature and humidity and but little rain. The last week was, however, much warmer than the earlier part of the month, and although during this earlier part vegetation was not so forward generally as it was a little before and after, still it was in advance of the average date.

The 5 species for July which usually come into flower in June averaged 7 days early, and the 5 which usually flower in July 4 days early. July was a warm month, but the species selected for it would be influenced only by the weather of June or of a still earlier period. The warm and dry weather of the last week in June would appear to have had some influence in the acceleration of the period of flowering.

The few records of species flowering later in the year are about the average dates; but the ivy (32), the only species in the list flowering so late as September, was out much earlier than usual.

XXVI.

REPORT ON INSECTS OBSERVED IN HERTFORDSHIRE DURING THE YEAR 1884.

By F. W. Silvester, F.R.Met.Soc.

Read at Hertford, 16th April, 1885.

The scanty information forwarded to me during the past year, by members of the Society and other friends, must be advanced as a plea for the brevity of the report it is my duty to submit to you. The subject of the recordership I have the honour of holding is one of such vital importance to agriculturists, gardeners, and the community at large, that it is much to be regretted that the county of Hertford, possessing an energetic Natural History Society doing immense practical good in many ways, should not be capable of furnishing the result of more observations than those I beg to offer for your acceptance this evening. I trust the naturalists present will do all in their power to supply more copious notes during this season, and induce their friends and neighbours to do the same, for in the compilation of a report of this kind "every little helps," and the smallest contribution will be thankfully received.

I am indebted to the following ladies and gentlemen for observations of first appearances—viz., Miss Simpson, of Sawbridgeworth; Mrs. Alfred Copeland, of Watford; Mr. W. Hill, jun., and members of the Hitchin Natural History Club; Mr. A. R. Kingston, of Royston; the Rev. Newton Price, of Bushey; Capt. R. B. Croft, of Ware; Mr. Chater, of Watford; Mr. R. T. Andrews, of Hertford; Mr. John J. Willis, of Harpenden; and Mr. John Hopkinson, of Watford. The following observations have been made:—

Melolontha vulgaris (cockchafer), seen at Hitchin, May 22nd; at Harpenden, May 23rd.

Rhizotrogus solstitialis (fernchafer), at Sawbridgeworth, July 1st.

Timarcha lævigata (bloody-nosed beetle), at Harpenden, March 16th.

Lampyris noctiluca (glow-worm), at Harpenden, June 12th.

Apis mellifica (honey-bee), at Royston, Jan. 1st; at Ware, Jan. 10th; at Watford, Feb. 13th; at Sawbridgeworth, April 21st.

Vespa vulgaris (common wasp), at Watford, March 28th; at Hertford, March 28th; at Harpenden, May 7th.

Pieris Brassicæ (large white butterfly), at Harpenden, March 15th (?); at Royston, April 26; at Watford, April 30th; at Hertford, April 30th; at Hitchin, May 5th.

Pieris Rapæ (small white butterfly), at Hitchin, March 8th; at Watford, March 15th; at Harpenden, April 2nd; at Royston, April 2nd; at Hertford, April 3rd.

Anthocaris cardamines (orange-tip butterfly), at Hitchin, May 17th; at Harpenden, May 18th.

Epinephile Janira (meadow-brown butterfly), at Hitchin, May 24th; at Harpenden, June 11th.

Bibio Marci (St. Mark's fly), at Hitchin, April 29th.

As in 1883, the larvæ of *Tipula oleracea* (daddy long-legs' grubs) were very destructive throughout the county, and many thin plants of wheat were the result. The expedient of the application of nitrate of soda or soot as a counteractive was largely adopted. In addition to its stimulating properties, the former has been proved by experiment to be especially obnoxious to these grubs, which have also a strong objection to a heavy roller.

My crops suffered very much from the turnip-fly (*Phyllotreta undulata*), and in one corner of one of the fields I had to sow three times, and then had to rest content with a very poor crop of white turnips, otherwise with the exception of a few patches the swede crop grew out of the way of these pests. In many places the turnip-root maggot, the larva of *Anthomyia floralis*, was very destructive. The rooks are great enemies of these maggots, and in a neighbouring county the services of these birds were invited in an ingenious manner. During the very dry weather of last summer a farmer noticed that some turnips growing in a field on the next farm were constantly visited by large flocks of rooks busily engaged in pecking at the grubs, while his own turnips were languishing, and not a rook would settle on his land. Viewing with envious eyes the salvation of his neighbour's crop, it struck him that the rooks frequently quenched their thirst at some water provided for sheep close by. He took the hint, and placed several water-troughs in his field, replenishing them when needed, the thirsty rooks took to his farm, and as a result of his forethought he had the gratification of seeing his turnips rally as their foes succumbed to the persistent attacks of his feathered friends. The above anecdote well illustrates the debt agriculturists owe to birds, and it may here be appropriate to mention a few varieties which are especially serviceable in warding off insect attacks. On grass, besides the warblers, swallows, swifts, martins, and partridges, the pipits and starlings are of use, and on marshy lands the wagtails are useful as feeding on the marsh-snail—the forerunner of the liver-fluke. The cuckoo preys on hairy larvæ, and the flycatcher has a great predilection for white butterflies. In our gardens, titmice and warblers, and the wren and the cuckoo, do good service among the raspberry, currant, and gooseberry bushes. The farmer will find the presence of the partridge, spotted flycatcher, martin, swallow, and swift very beneficial among his turnips and cabbages. The market-gardener will find very serviceable among his apple and fruit trees the titmice, warblers, woodpeckers, nuthatch, and tree-creepers.

This is a fitting place to allude to the sparrow question, which has received much attention at the hands of Miss E. A. Ormerod, F.R.Met.Soc. The eminent consulting entomologist to the Royal Agricultural Society of England has strongly urged the destruction of these mischievous birds, which drive away insectivorous birds and do much harm at harvest time. Any suggestion of Miss Ormerod's carries great weight, and many in Hertfordshire have doubtless joined in the sparrow crusade, which should be renewed with vigour now that nesting-time is upon us. In addition to her

varied valuable labours, this county, in common with all other farming and grazing districts, is greatly indebted to the same talented lady for the observations on the "warble fly, or ox-bot fly," and the means found practicable and serviceable for its prevention, as published in her annual report on "Injurious Insects and common farm pests." The great damage done to hides, as well as the importance of having our cattle in a healthy and thriving state, makes the question an important one to all agriculturists, who should at once take steps to apply mercurial ointment to the warbles which will appear in their herds this month and next. Mr. Stratton, of Newport, says: "I am persuaded that no remedy can be more safe, simple, and effectual than this. It would not cost more than twopence a head to treat all the cattle in the country in this way."

Last year we had abundant crops of nuts and acorns, but the quantity of each attacked by the weevil was very great.

Mr. John Hopkinson reports that several of his rose-trees were completely spoiled by caterpillars of the buff-tip moth during the past summer, in his garden at Wansford House, Watford. The attack was noticed as being more prevalent amongst the richer-foliaged bushes. The caterpillars were, in a measure, got rid of by handpicking.

Miss Ormerod states that "surface caterpillars" (or larvæ of turnip moth—*Agrotis segetum*; heart and dart—*A. exclamationis*; and yellow underwing—*Tryphæna pronuba*) did more harm than usual last year, because the warm and settled weather was favourable to the moth, and the young caterpillars were not materially lessened in numbers by heavy rains, often so effectual in checking moth-caterpillar ravages.

Thinking that a passing allusion to the ravages of injurious insects among our woods and forests might be interesting, I applied to Mr. Walter Rogers, of Watford, for a little information on the subject, and he kindly writes as follows:—"I tried to find you a piece of wood with one of the wood-grubs in, but have been unsuccessful. My men have cut them out of the heart of trees which must have been from 60 to 100 years old, as long as my finger and as large, with heads as hard as the wood itself, or nearly so. They have no doubt worked their way from the bottom of the tree. I am sorry I cannot furnish you with further particulars at the present moment." Insect injury to timber is well worth the consideration of our great landowners and others.

In conclusion, I beg to express the hope that East and West Herts will vie with each other to overwhelm me with subject-matter for next year's report.

XXVII.

MISCELLANEOUS NOTES AND OBSERVATIONS.

Read at Watford, 24th March, 1885.

Meteorology.

Whirlwind at Ivinghoe, 11th September, 1834.—It will be remembered by those who attended our meeting held at Watford on the 20th November, 1883, that I alluded from memory to a very remarkable whirlwind which occurred, many years ago, in the neighbourhood of Ivinghoe, a small village situate at the foot of the Chiltern Hills, not far from the Bridgewater monument. Mr. Symons, who was present on the occasion, thought it desirable that some particulars of the event should be recorded in the pages of our Transactions, and at the request of our Secretary I agreed to furnish my boyish recollections of what I saw. Fortunately I have succeeded in obtaining a very interesting narrative of the storm and its effects, written by my uncle, the late Mr. Thomas Squire, of Berkhamsted, in whose company I visited the spot, and who wrote the account from notes taken at the time. It is far more circumstantial and accurate than anything that I could have supplied from memory, and I have much pleasure in reading it.

"On the 11th of September, 1834, a violent storm of wind accompanied by hail passed over the village of Ivinghoe, and did much damage. It appears to have resembled a West-Indian tornado, except that it was confined to a comparatively small space, its utmost fury not extending beyond a circle somewhat exceeding half a mile in diameter. It is almost beyond the power of the writer to present the account in a sufficiently characteristic form, but as such phenomena are of rare occurrence in this country, the following particulars may not be uninteresting. It was about six o'clock in the evening when, to use the expression of a credible eye-witness, 'a dense smoke, comparable to that issuing from a large furnace, advanced so rapidly up the valley that it gave the idea of rising out of the ground.' The air became suddenly darkened, and almost as suddenly the darkness cleared away, leaving the sky remarkably bright. It only lasted about three minutes, but during this short period its devastating effects, as visible four days afterwards, when visited by the writer of this account, may be summarised as follows. A barn, the floor of which had been newly laid, was completely rolled over, the new floor being thrown to a distance of about 40 feet beyond the rest of the building. In the same farmyard, a shed, 60 feet long, under which a man was milking a cow, was completely lifted over his head and dropped at some little distance, without hurting either man or cow. The milkman informed us that he was stunned, and he appears unable to give a very clear account of his feelings. Another shed was partly unroofed and shifted its foundation a few inches without falling. Not far from these premises was a cottage where some children were at school; the door was suddenly burst open, and a

piece of wood, weighing about 14lbs., flew in, struck a man on the chest, and then rebounded on to a little boy about 7 or 8 years old, breaking one of his thighs and dislocating his knee. A tree 16 inches in diameter was broken off by the roots and fell with such violence on a brick tenement that it nearly demolished it, only one room being left standing, and a large aperture being conspicuous in the walls of that. In the opposite corner was the woman of the house with her two children, all of whom were mercifully preserved from bodily harm. The husband was from home, but near enough to witness the destruction of his cottage and to meet his wife running from the spot with her two children under her arms. In the neighbouring meadow two trees of large dimensions were blown down, and about 30 others were much injured. The most extraordinary occurrence observable in the meadow was that of a large oak tree, nine feet round the trunk, with a beautiful spreading top, 'as round,' said our guide, 'as an apple;' the wind took this tree and lifted it perpendicularly out of the ground to the height of several feet, whirling it round repeatedly before it fell, after which it was again raised and thrown over in an opposite direction. The weight of earth that was attached to the roots is estimated at from three to four tons, and the pieces of branches that flew about were compared by our guide, from their rotatory motion, to the wheeling flight of a multitude of swallows. One field distant was a farm and small orchard in which nearly all the fruit trees were blown down; adjoining the orchard was a barn, and a shed containing a barley stack and some wheat in sheaf: some of the sheaves of wheat were picked up next morning at a distance of two miles from the shed; they were threshed out as completely as by machine or flail. The top of an elm tree, a foot in diameter where broken off, was carried at least 60 feet, and penetrated the barley stack about 5 feet, driving before it a sheaf of wheat which it had arrested in its flight. Apples, that must have been carried half a mile, were found in the wheat stack; two coal carts were overturned, the wheels of one of them continuing to spin round with astonishing rapidity; the chapel was much injured; a double tenement just erected, but not quite finished, was so broken that it had to be taken down; and lastly about 600 panes of glass and many window-frames were broken. The damage is estimated at £1000."

I distinctly remember that the track of the whirlwind was readily distinguishable for a considerable distance across country by the *débris* that was left behind it. The meadows over which it passed were plentifully strewn with hay, straw, and the broken branches of trees, the thorn hedges that divided the meadows being completely smothered with similar material.—*John E. Littleboy, Hunton Bridge, Watford.*

Ornithology.

Curious Habit of the Wagtail.—It is possible that the following observation may be of some interest to the ornithological members of the Society. For the last nine or ten months a pair of

common pied wagtails have spent their time for hours daily in flying up to the window-panes in this house, in search apparently, as we first supposed, of flies and other insects. It might have been expected that the birds would alight on the sash-frames and sills, to pick out any microscopic animalculæ there might be in the crevices of the putty and frames, but such is rarely the case. As a rule the birds do not alight at all, but fly up against the centre and general surface of the panes, almost as if they did not expect to meet with any obstacle to entering the room; they tap loudly on the glass and plant their feet on the surface, the wings being constantly on the move, then they fly off to reappear in the same manner the next minute. When the weather is wet, they are a positive nuisance, as the birds cover the plate-glass all over with muddy impressions of their feet, but I have not the heart to have them destroyed. My gardener opines that "They are mad, sir," an opinion to which I give the weight which it deserves. We might also have anticipated, I think, that the wagtails would have discontinued their pursuits during the winter months, when, if ever, there must be few, if any, insects of appreciable dimensions on the windows; but not so, day after day, throughout January, February, and March, when I have been here for short periods, I have seen this industrious pair at their work of dirtying my windows. Another somewhat curious trait of character in these little creatures is that they manifestly prefer society. As members of my family move from room to room the birds habitually follow—selecting a window through which they can perceive the presence of their human friends. Perhaps some experienced ornithologist will explain whether there be anything exceptional in this case.—*J. Henry James, Kingswood, Watford.*

XXVIII.

METEOROLOGICAL OBSERVATIONS TAKEN AT THROCKING, HERTS, DURING THE YEAR 1884.

By the Rev. C. W. Harvey, M.A., F.R.Met.Soc.

Read at Hertford, 15th April, 1885.

Position of Station.—Lat. 51° 57′ N., Long. 0° 3′ W.; River District of the Rib; Height of Station above sea-level, 484 feet; Time of observing, 9 a.m.

In the following report of my own observations, being the fifth I have had the honour of laying before the Society, I shall compare the present year, 1884, with the mean of the 5-year period 1880–84; the terms "mean of the period" and "period" must therefore be understood to refer to these five years.

The most striking feature in the weather of 1884 is its extreme *dryness*, a feature more especially observable upon this side of the county. Judging by the Royston records of rainfall it has been the driest year since 1864. By the table in which I have compared the observations of the present year with the mean of the period, it will be seen that as regards *pressure* the yearly mean, and in most cases the monthly mean, was above the mean of the period, a deficiency being observable in the spring months; as regards *temperature* the only months which showed deficiency were April, June, and November; whilst as regards *rainfall* the only months in excess were January, March, and July, the excess in March being so slight as to be scarcely noticeable.

Months.	Pressure.		Temperature.		Rainfall.	
	Mean 1880–84.	Diff. 1884.	Mean 1880–84.	Diff. 1884.	Mean 1880–84.	Diff. 1884.
January	30·12	+·04	36·1	+5·7	1·39	+ ·68
February	29·93	+·03	39·6	+0·4	2·28	−1·61
March	29·96	−·02	41·4	+1·3	1·05	+ ·02
April	29·90	−·06	45·3	−2·3	1·69	− ·72
May	30·04	−·06	51·2	+1·5	·87	− ·48
June	29·95	+·06	56·6	−0·7	1·95	− ·66
July	29·93	+·10	60·6	+0·4	3·21	+ ·20
August	29·97	+·17	59·8	+3·3	2·27	− ·36
September	29·93	+·10	56·0	+2·2	2·53	−1·02
October	29·95	+·17	47·3	+0·6	3·15	−2·12
November	29·93	+·28	42·1	−1·3	2·43	− ·78
December	29·94	+·04	38·4	+0·2	2·55	− ·13
Year	29·96	+·07	47·9	+0·9	25·37	−6·98

Pressure.—Upon the whole the barometer remained steady, and the rising and falling were effected gradually; only one depression could be called exceptional, that of January 26th, during a gale

Results of Meteorological Observations taken at Throcking Rectory, Buntingford, in 1884.

Months.	Pressure of the Atmosphere.	Temperature of the Air.										Humidity of the Air.		
		9 a.m.	Means of		Adopted Mean.	Mean Daily Range.	Absolute Min. and Max.				Absolute Range.	Dryness.	Tension of Vapour.	Relative Humidity.
			Min.	Max.			Min.	Date.	Max.	Date.				
	ins.	°	°	°	°	°	°		°		°	°	in.	%
January	30·16	40·5	37·1	46·2	41·8	9·1	30·4	2nd	51·4	22nd	21·0	1·4	·239	95
February	29·90	39·2	34·8	45·3	40·0	10·5	26·7	3rd	53·9	13th	27·2	1·8	·224	94
March	29·94	41·8	35·2	50·7	42·7	15·5	27·3	3rd	66·2	16th	38·9	3·6	·231	88
April	29·84	45·2	35·6	51·2	43·0	15·6	26·9	23rd	65·8	2nd	38·9	5·4	·246	81
May	29·98	55·0	42·8	66·0	52·7	23·2	31·4	1st	77·3	24th	45·9	6·9	·337	78
June	30·01	57·5	47·8	65·3	55·9	17·5	38·9	1st	77·7	13th	38·8	5·1	·394	83
July	30·03	63·2	52·6	70·8	61·0	18·2	42·4	26th	83·4	4th	41·0	3·9	·507	87
August	30·14	64·5	53·9	73·6	63·1	19·7	41·9	26th	87·7	11th	45·8	7·5	·466	77
September	30·03	57·3	51·1	66·0	58·2	14·9	42·4	30th	81·4	17th	39·0	3·2	·419	89
October	30·12	47·8	41·6	54·6	47·9	13·0	33·3	29th	60·4	17th	27·1	2·7	·300	91
November	30·21	40·2	35·8	44·9	40·8	9·1	25·1	26th	58·4	5th	33·3	1·8	·232	94
December	29·98	38·3	34·9	42·1	38·6	7·2	26·4	1st	52·0	6th	25·6	1·7	·218	94
Year	30·03	49·2	41·9	56·4	48·8	14·5	25·1	Nov 25	87·7	Aug. 11	62·6	3·7	·318	88

RESULTS OF METEOROLOGICAL OBSERVATIONS TAKEN AT THROCKING RECTORY, BUNTINGFORD, IN 1884—(*continued*).

MONTHS.	RAINFALL.					CLOUD.			WIND.									
	Total Fall.	Max. fall in 24 hours.		No. of days of		Mean Amount 0–10.	No. of days of		Mean Force 0–12.	Number of days of								
	Ins.	Ins.	Date.	Rain or Snow.	Snow only.		Clear Sky.	Overcast.		N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Calm.
January....	2·07	·52	26th	15	0	8·0	3	19	3·0	1	0	1	0	7	11	5	5	1
February	·67	·12	21st	13	0	7·2	3	15	3·0	1	2	4	3	7	8	2	2	0
March	1·07	·40	3rd	6	0	6·1	4	10	2·5	4	5	3	1	9	2	2	2	3
April	·97	·22	6th	16	0	6·5	2	7	2·5	5	9	4	1	6	1	0	2	2
May	·39	·25	3rd	6	0	5·0	6	5	3·2	2	6	5	1	4	8	4	1	0
June	1·29	·40	7th	8	0	6·2	4	10	2·3	11	1	2	2	4	1	1	5	3
July	3·41	1·60	9th	11	0	6·7	4	12	1·8	1	2	1	1	3	12	3	4	4
August	1·91	·94	9th	9	0	4·5	5	8	1·8	2	0	4	1	8	5	4	3	4
September	1·51	·56	3rd	11	0	6·1	5	12	2·6	3	3	3	3	7	3	2	5	1
October	1·03	·47	9th	11	0	6·6	5	11	2·8	5	1	0	1	5	1	9	8	1
November	1·65	·56	30th	12	1	7·2	4	14	2·2	5	1	3	0	7	2	2	7	3
December	2·42	·36	7th	19	2	8·5	0	21	3·0	5	1	4	1	2	13	2	2	1
Year	18·39	1·60	July 9	137	3	6·5	45	144	2·6	45	31	34	15	69	67	36	46	23

from the S.W. with heavy rain. I observed this pressure at periods of six hours with the following result:—26th, 9 a.m. 29·26, 3 p.m. 28·90, 9 p.m. 28·47 ; 27th, 3 a.m. 28·72, 9 a.m. 28·97. The minimum, 28·47 ins. at 9 p.m. on 26th, was the lowest pressure yet recorded in the 5-year period, the range of which is now 2·47 inches, namely, from 30·94 on January 18th, 1882, to 28·47 on January 26th, 1884. On January 16th the barometer stood at 30·63 ins. Consequently the range for January was nearly the range for the whole year, the year's range being from 30·74 on Oct. 5th, to 28·47 on January 26th, or 2·27 inches. The only other days on which pressure exceeded 30·50 ins. were October 4th (30·52) and 6th (30·56), and no other instance occurred of its being less than 29 inches. This year's range of pressure exceeded that of any other in the period by 0·21 inch.

Temperature.—The mean temperature of the year, 48°·8, was the highest yet recorded, and was 0°·9 in excess of the mean of the period. The range for the year was from 87°·7 on August 11th, to 25°·1 on Nov. 25th; the maximum registered this year (87°·7) being the second highest maximum of the period. The four highest maxima and lowest minima during the year were :—

Highest Maxima.		Lowest Minima.	
(*a*) August 11th	87°·7	(*a*) Nov. 25th	25°·1
(*b*) August 8th	86 ·4	(*b*) Nov. 30th	25 ·4
(*c*) July 4th	83 ·4*	(*d*) April 17th	25 ·9
(*d*) August 7th	81 ·4†	(*c*) Dec. 1st	26 ·4

* and on August 9th and 24th. † and on September 17th.

By these four lowest minima it will be seen that there have been no severe frosts.

The warmest and coldest period of 14 days was August 5th to 18th on the one hand, and December 18th to 21st on the other.

Warmest Period (*Mean*).				Coldest Period (*Mean*).			
Aug. 5th.....	60·8	Aug. 12th.....	68·5	Dec. 18th.....	37·6	Dec. 25th.....	34·2
,, 6th.....	61·0	,, 13th.....	66·0	,, 19th.....	37·4	,, 26th.....	32·3
,, 7th.....	67·5	,, 14th.....	62·0	,, 20th.....	37·7	,, 27th.....	32·7
,, 8th.....	71·8	,, 15th.....	63·0	,, 21st.....	35·1	,, 28th.....	33·3
,, 9th.....	71·7	,, 16th.....	63·5	,, 22nd ..	36·6	,, 29th.....	33·7
,, 10th.....	67·9	,, 17th.....	65·8	,, 23rd.....	34·0	,, 30th.....	32·5
,, 11th.....	73·5	,, 18th.....	65·7	,, 24th.....	33·8	,, 31st.....	31·9
Mean 66·4.				Mean 34·6.			

From this it appears that the warmest and coldest fortnight in the present year were each considerably warmer than the warmest and coldest fortnight in any previous year of the five.

Rainfall.—Considerably below the mean. The only months which were in excess were January and July, the former owing to the fall of the 26th (0·52), the latter owing to the very heavy rain (1·60) which accompanied the **TSS** of the 9th. This max. fall of 1·60 in. was the max. fall of the whole 5-year period.

Dry Periods.—These were of very frequent occurrence, the most prolonged being from March 11th to April 1st, during which no rain at all fell; May 4th to June 4th, during which only a total of 0·15 fell upon 5 days; and June 10th to July 8th, during which a

total of 0·04 fell upon 3 days. *Wet Periods.*—The heaviest rainfall was between July 9th and 11th, 2·12 ins. falling on those 3 days. Rain fell very frequently between November 30th and December 21st, though in no large quantities except on the last day of November.

From the following table it will be seen that when compared with previous years the winter season of 1883–84 was the warmest and driest; the spring was the driest but with the lowest mean pressure; the summer was the hottest with the highest mean pressure; and the autumn was the driest with the highest mean pressure, the temperature being very similar to that of 1883, and higher than in any other autumn in the period.

Seasons, 1883–84.	Mean Pressure.	Mean Temperature.	Mean Daily Range.	Tension of Vapour.	Relative Humidity	Rainfall.
	ins.	°	°	ins.	%	ins.
Winter	30·06	39·8	9·3	·227	95	3·75
Spring	29·92	46·1	18·1	·271	82	2·43
Summer	30·06	59·3	18·5	·456	82	6·61
Autumn	30·12	49·0	12·3	·317	91	4·19

In conclusion, I will proceed to give a few notes on the months, as I have generally done.

January. — Mild and fine, but ending somewhat stormily. *Pressure*, which was slightly above the mean, was highest, 30·63, on 16th, and lowest, 28·47, on 26th. *Temperature* was very considerably above the mean, and the highest mean temp. of the period for January; warmest day 48°·1 on 23rd; coldest day 34°·2 on 1st; highest in sun 116°·0 on 2nd; lowest on grass 27°·0 on 29th. Accumulated temperature since January 1st above 42° was 54°, and below 42° was 93°. *Rainfall* was somewhat above the mean; between 9th and 21st only 0·03 fell, on one occasion; chief falls other than max., 0·20 on 24th, and 0·22 on 25th. *Prevailing winds*, S. and S.W.; gale on 26th.

February.—A mild dry month, as far as I am able to ascertain the driest February since 1863. *Pressure*, which was slightly below the mean, was highest, 30·15, on 14th, and lowest, 29·43, on 1st. *Temperature* was a trifle above the mean; warmest day 46°·9 on 13th; coldest day 33°·4 on 29th; highest in sun 95°·8 on 20th; lowest on grass 23°·5 on 29th. Accumulated temperature since January 1st above 42° was 91°, and below 42° was 206°. *Rainfall* was much below the mean, less even than a third of the mean, and no fall other than max. reached even a tenth of an inch. *Prevailing winds*, S. and S.W.

March.—A bright calm month, and very dry after the 10th. *Pressure*, which was slightly below the mean, was highest, 30·18, on 27th, and lowest, 29·19, on 10th. *Temperature* was somewhat above the mean; warmest day 48°·4 on 16th; coldest day 33°·7 on 1st; highest in sun 111°·4 on 16th; lowest on grass 22°·6 on

3rd. Accumulated temperature since January 1st above 42° was 239°, and below 42° was 289°. *Rainfall* was as nearly as possible the mean; chief falls other than max., 0·40 on 3rd, 0·35 on 10th, after which no rain fell; **S** on 4th. *Prevailing wind*, S.

April.—Somewhat cold and dry. *Pressure*, which was below the mean, was highest, 30·09, on 18th, and lowest, 29·35, on 5th. *Temperature* showed a greater deficiency than in any other month, and was the lowest mean temp. for April in the period; warmest day 53°·5 on 3rd; coldest day 34°·7 on 19th; highest in sun 116°·1 on 2nd; lowest on grass 28°·0 on 12th. The beginning of the month was warmer than its close. Accumulated temp. since January 1st above 42° was 387°, and below 42° was 365°. *Rainfall* was considerably below the mean; chief fall other than max., 0·18 on 27th. *Prevailing wind*, N.E. The earthquake of 22nd was felt in the neighbouring town of Buntingford, though not perceived at this station. A rumbling sound like distant thunder was, however, noticed about the time of its occurrence.

May.—A bright warm dry month, the warmest and driest May of the period. *Pressure*, which was slightly below the mean, was highest, 30·46, on 22nd, and lowest, 29·35, on 4th. *Temperature* was somewhat above the mean, and was the highest May mean temp. of the period; warmest day 61°·3 on 17th; coldest day 42°·3 on 1st. Max. exceeded 72° on 6 days; highest in sun 127°·7 on 25th; lowest on grass 30°·0 on 5th; last trace of frost on 7th. Accumulated temp. since January 1st above 42° was 752°, and below 42° was 365°. *Rainfall* was very small indeed, less than half the mean, with no fall of any consequence other than max., and no rain after 14th. *Prevailing winds*, S.W. and N.E.

June.—A dry bright month, but somewhat cold; the driest June of the period. *Pressure*, which was slightly above the mean, was highest, 30·28, on 13th, and lowest, 29·57, on 7th. *Temperature* was low until the end of the month; warmest day 63°·6 on 28th; coldest day 48°·0 on 9th; highest in sun 130°·8 on 13th; lowest on grass 35° 5 on 1st; it was also low (38°·6) on 2nd and (38°·1) on 18th. Accumulated temp. since January 1st above 42° was 1169°, and below 42° was 365°. *Rainfall.*—The whole rainfall of the month with a very trifling exception occurred between 4th and 9th; the only fall of any consequence other than max. fall was 0·37 on 7th; rain was gauged at neighbouring stations on 29th, but none fell at Throcking. *Prevailing wind*, N.

July. — A month of real summer weather, with somewhat frequent electrical disturbances. *Pressure* was above the mean, and the highest July mean pressure of the period; highest, 30·27, on 30th; lowest, 29·77, on 15th. *Temperature* was very little in excess of mean; warmest day 71°·6 on 8th; coldest day 52°·1 on 26th; highest in sun 133°·5 on 6th; lowest on grass 33°·5 (?) on 26th (this was the actual reading, but it requires substantiation). The max. was above 82° on one day. Accumulated temp. since January 1st above 42° was 1751°, and below 42° was 365°. *Rainfall* was slightly in excess of mean, owing to **TSS** of 9th (1·60);

1½ inch fell in 2 hours. The chief falls other than max. were 0·40 on 25th, and 0·33 on 10th, and again on 20th. *Prevailing wind*, S.W.

August.—Fine and warm, the warmest August of the period; electrical disturbances were again somewhat prevalent. The storm of the 9th broke very suddenly and completely over Throcking, the lightning striking the neighbouring Rectory of Aspenden. *Pressure* was somewhat above the mean; highest, 30·32, on 5th; lowest, 29·86, on 29th. *Temperature* was very considerably above the mean; warmest day 73°·5 on 11th; coldest day 48°·6 on 26th; highest in sun 136°·9 on 9th; lowest on grass 33°·0 (?) on 26th (such was the reading, which, as in the previous month, requires to be substantiated). The max. was above 82° on four days. Accumulated temp. since January 1st above 42° was 2397°, and below 42° was 365°. *Rainfall* was somewhat deficient; during **TS** of 9th 0·80 fell in one hour. Chief falls other than max., 0·32 on 27th, and 0·29 on 31st. *Prevailing wind*, S.

September.—Warm and dry, but little rain falling after 4th. *Pressure* was above the mean; highest, 30·41, on 12th; lowest, 29·49, on 4th. *Temperature* was also above the mean; warmest day 70°·4 on 17th; coldest day 50°·7 on 6th; highest in sun 122°·8 on 16th; lowest on grass 34°·0 on 6th. Accumulated temperature since January 1st above 42° was 2880°, and below 42° was 365°. *Rainfall* was very considerably below the mean; chief fall other than max., 0·30 on 4th. *Prevailing wind*, S.

October.—A dry month with average temperature. *Pressure* was slightly above the mean; highest, 30·74, on 5th (max. of year); lowest, 29·52, on 10th. *Temperature* was a trifle above the mean; warmest day 56°·0 on 17th; coldest day 39°·7 on 11th; highest in sun 111°·2 on 1st; lowest on grass 29°·6 on 29th; first trace of frost on 9th. Accumulated temp. since January 1st above 42° was 3060°, and below 42° was 370°. *Rainfall*, excepting between 8th and 13th, was small, very considerably below the mean; the driest October of the period, max. being only fall of any importance. *Prevailing winds*, W. and N.W.

November.—A dry calm month, somewhat cold; snow on 21st, and fall of 6 ins. (of snow) on 30th. *Pressure* was above the mean; highest, 30°·55, on 14th; lowest, 29°61, on 10th. *Temperature* was somewhat below the mean; warmest day 51°·9 on 5th; coldest day 29°·2 on 30th; highest in sun 92°·8 on the 1st and 5th; lowest on grass 21°·6 on 25th. Accumulated temp. since January 1st above 42° was 3093°, and below 42° was 472°. *Rainfall* was below the mean, and this was the driest November of the period; little fell after 7th until snow on 30th. Chief fall other than max., 0·38 on 5th. *Prevailing winds*, S. and N.W.

December.—Rain fell almost daily until 20th, the falls, however, though frequent, were not large, and the weather throughout the month remained open. *Pressure* was slightly above the mean; highest, 30°·30, on 22nd; lowest, 29°·26, on 4th. *Temperature* was also slightly above the mean; warmest day 49°·8 on 5th; coldest

day 31°·9 on 31st; highest in sun 75°·1 on 5th; lowest on grass 23°·6 on 31st. Accumulated temp. since January 1st above 42° was 3094°, and below 42° was 585°. *Rainfall* frequent until 20th, then dry, only slightly in excess of mean. Chief falls other than max., 0·35 on 5th, 0·26 on 14th and again on 18th, 0·19 on 4th, and 0·17 on 2nd. *Prevailing wind,* S.W.

By far the most important occurrence during the year was the severe shock of earthquake which worked such havoc in the neighbouring county of Essex, on April 22nd, and of which a very complete account appeared in Symons' 'Meteorological Magazine' for May, 1884. It is always interesting to trace the limits to which such disturbances are felt, and I can bear testimony to the shock having been felt in Buntingford. A servant in the town, whilst about her household work upstairs, noticed a sound as of some one walking across the room, and causing the glasses, etc., on the washstand to jar; turning round, expecting to see her fellow-servant, and seeing no one, the girl rushed down in a fright, and related what she had experienced.

At about 9 a.m. on the same morning an inhabitant of this parish heard a rumbling sound, which she imagined to be thunder, remarking at the time that she thought it had just thundered; but whether this was only a coincidence, or had anything to do with the shock, I cannot say.

XXIX.

REPORT ON THE RAINFALL IN HERTFORDSHIRE IN 1884.

By the Rev. C. W. Harvey, M.A., F.R.Met.Soc.

Read at Hertford, 15th April, 1885.

I am sorry to report a slight decrease in the number of stations recording, and in the number of gauges at work. Instead of 29 stations, we have this year only 28, from one of which no return has been received; and instead of 33 gauges, we have this year only 31 in working order. Two observers have discontinued their records, viz., Rev. J. O. Seager at Stevenage, whose observations have extended over 15 years, and Mr. McKenzie at Hoddesdon; and at Brocket Hall the record is this year defective. On the other hand, we have gained a fresh observer in Dr. Parker of Bennington, near Stevenage, a most enthusiastic meteorologist.

The present year, as will be seen by a glance at the accompanying table, and by comparing that table with previous ones, proved a remarkably dry year; certainly the driest since 1874, and at some stations—notably Berkhamsted and Royston—since 1864. It may be worthy of remark that for the last half century every tenth year has proved a dry year, *i.e.* 1834, 44, 54, 64, 74, and 84.

Distribution of Rainfall throughout the Year.—Whether we divide the year into quarters, or into seasons, we find a deficiency in each quarter and in each season, as will be seen by the following comparison of the rainfall of 1884 with that of the mean of 1870-79:

	ins.		ins.
1st Quarter	—1·21	Winter Months	—0·49
2nd ,,	—2·56	Spring ,,	—2·60
3rd ,,	—1·89	Summer ,,	—1·19
4th ,,	—1·68	Autumn ,,	—3·06

Thus spring and autumn were the driest seasons of a dry year, and May was the driest month. If any single month could be called wet, it would be December. July was the only other month besides December, the rainfall of which exceeded the mean, and this was on account of several heavy thunderstorms. The relation which the mean monthly fall of 1884 bears to the mean of 1870-79 is as follows:—

	in.		in.		in.		in.
Jan.	—0·24	April	—0·78	July	+0·15	Oct.	—1·16
Feb.	—0·75	May	—1·60	Aug.	—1·16	Nov.	—1·02
Mar.	—0·22	June	—0·18	Sept.	—0·88	Dec.	+0·50

Distribution of Rainfall throughout the County.—Though upwards of 7 inches below the mean fell in each of the two main River Basins of the Thames and Ouse, the deficiency was rather more apparent in the former. In the five districts into which these two river basins are divided, whilst the deficiency was considerable both in the Colne and Lea divisions, it was most noticeable in that of the Cam.

Table I.—Hertfordshire Rainfall Stations.

River District.		Station.	Observer.	Latitude.	Longitude.	Diameter of Gauge.	Height of Gauge above Ground.	Height of Gauge above Sea-level.	
				° ′ ″	° ′ ″	ins.	ft. ins.	ft.	
Thame	Up. Thame	Tring—The Vicarage	Rev. W. Quennell	51 47 33 N	0 39 25 W	5	1 0	442	T
Colne.	Lower Colne	Watford—Watford House	Alfred T. Brett, M.D.	51 39 25 N	0 23 35 W	5	1 0	240	T
		,, Wansford House	John Hopkinson	51 39 45 N	0 23 40 W	5	1 0	224	T
		Rickmansworth—Moor Park	Lord Ebury	51 37 30 N	0 26 20 W	5	2 0	340	⅄
	Ver	St. Albans—Gorhambury	The Earl of Verulam	51 45 20 N	0 23 0 W	6	2 6	425	
		Harpenden—Rothamsted	Sir J. B. Lawes and Dr. Gilbert	51 48 10 N	0 21 30 W	5	0 9	420	T
		,, ,, (2nd gauge)		51 48 10 N	0 21 30 W	72 × 87	0 9	420	T
		,, ,, (3rd gauge)		51 48 10 N	0 21 30 W	8	0 9	420	T
		Dunstable—Kensworth	Miss Grace Jones	51 51 30 N	0 30 0 W	5	1 5	630	B
	Gade and Bulbourne.	Hemel Hempsted—Nash Mills	J. Dickinson & Co.	51 44 0 N	0 26 40 W	12	3 9	237	T
		,, Great Gaddesden	Rev. W. T. Drake	51 47 20 N	0 30 30 W	8	1 0	426	⅄
		Berkhamsted	William Squire	51 45 40 N	0 33 30 W	8	1 6	370	B
		Tring—Cowroast	Hubert Thomas, C.E.	51 47 0 N	0 36 30 W	10	4 2	345	L
Lea.	Lower Lea	East Barnet—Southgate	H. P. Church	51 37 40 N	0 8 0 W	5	0 6	240	T
	Upper Lea	Ware—New River Company	F. Francis, C.E.	51 46 0 N	0 6 0 W	12	3 0	114	T
		,, Fanhams Hall	Miss J. Croft	51 49 30 N	0 1 30 W	8	1 0	253	
		Hertford—Bayfordbury	W. Clinton Baker	51 46 30 N	0 5 30 W	8	0 4	250	
		Hatfield—Brocket Hall	Hon. H. F. Cowper, M.P.	51 48 0 N	0 14 0 W	8	1 0		
	Mimram	Welwyn—The Rectory	Rev. C. L. Wingfield	51 49 50 N	0 12 30 W	5	0 4	228	T
		,, Datchworth	Rev. J. Wardale	51 51 0 N	0 10 0 W	6	1 0	386	T
	Beane	Stevenage—Bennington	Rev. J. D. Parker, LL.D.	51 53 45 N	0 5 20 W	5	1 0	480	⅄
		,, Knebworth	Rev. F. G. Jenyns	51 52 30 N	0 12 30 W	5	1 0	391	⅄
	Rib	Buntingford—Throcking	Rev. C. W. Harvey	51 57 5 N	0 3 0 W	5	1 0	484	T
		Royston—Therfield	Rev. J. G. Hale	52 1 0 N	0 3 0 W	5	4 3	500	
	Ash	Ware—Fanhams Hall	Miss J. Croft	51 49 0 N	0 1 0 W	5	1 0	253	
		,, Much Hadham	T. W. Mott	51 51 24 N	0 4 38 E	5	1 0	222	B
Cam. Ivel.	Hiz	Hitchin	William Lucas	51 57 0 N	0 16 20 W	5	2 1	238	⅄
		,, High Down	Joseph Pollard	51 57 40 N	0 20 0 W	5	1 1	422	⅄
	Rhee	Royston	H. Wortham	52 2 34 N	0 1 8 W	8	0 6	269	⅄
		,, Odsey Grange	H. G. Fordham	52 1 28 N	0 6 41 W	5	1 0	263	⅄
		,, ,, ,,	,, ,,	52 1 28 N	0 6 41 W	5	1 0	263	⅄
		,, Barley	Rev. C. O. Miles	52 1 0 N	0 3 0 E	5	1 0	322	

TABLE II.—SHOWING THE RAINFALL AT VARIOUS STATIONS IN HERTFORDSHIRE IN 1884.

STATIONS.	JAN.	FEB.	MAR.	APL.	MAY.	JUNE.	JULY.	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL.	DAYS.
Tring—The Vicarage	3·38	1·58	1·95	1·53	·62	3·15	2·84	1·73	2·00	1·11	1·87	3·06	24·82	156
Watford—Watford House ...	2·39	1·12	1·59	1·37	·57	2·29	2·44	1·35	1·52	1·13	2·11	2·90	20·78	159
,, Wansford House...	2·90	1·29	1·96	1·34	·65	2·39	2·44	1·15	1·45	1·15	2·26	3·37	22·35	152
Rickmansworth—Moor Park	3·12	1·13	1·88	1·57	·81	2·19	2·11	1·38	1·60	1·20	2·73	3·59	23·31	155
St. Albans—Gorhambury ...	2·97	1·71	1·95	1·67	·52	3·11	2·10	1·31	1·75	1·50	1·34	3·66	23·59	127
Harpenden—Rothamsted	2·55	1·38	1·64	1·74	·61	2·46	2·40	1·56	2·11	1·64	1·87	3·06	23·02	147
,, ,, (2nd gauge)	2·56	1·42	1·66	1·79	·64	2·50	2·44	1·59	2·19	1·70	2·05	3·06	23·60	156
,, ,, (3rd gauge)	2·51	1·31	1·59	1·69	·58	2·43	2·34	1·51	2·05	1·60	1·86	2·96	22·43	141
Dunstable—Kensworth	2·26	1·20	1·58	1·62	·47	2·71	2·75	1·85	1·92	1·55	1·52	2·74	22·17	134
Hemel Hempsted—Nash Mills	2·49	1·64	1·97	1·54	·59	2·46	2·10	1·26	1·81	1·41	2·13	3·12	22·52	130
,, Great Gaddesden	2·39	1·10	1·60	1·38	·58	2·19	2·16	1·59	1·95	1·46	1·65	3·07	21·12	145
Berkhamsted	2·59	1·36	2·02	1·42	·57	2·24	2·92	1·50	2·02	1·40	2·08	3·32	23·44	143
Tring—Cowroast	2·99	1·41	1·89	1·53	·66	2·34	2·95	1·10	2·23	1·45	1·24	3·96	23·75	119
East Barnet—Southgate	2·44	1·60	1·65	1·28	·71	2·85	2·16	·84	1·49	1·30	2·44	3·38	22·14	155
Ware—New River Company	2·22	1·02	1·35	·97	·37	2·54	2·15	·96	1·32	1·09	1·65	2·46	18·10	138
,, Fanhams Hall.....	2·39	·85	1·50	·92	·31	2·66	2·81	1·20	1·62	1·33	1·74	2·98	20·31	130
Hertford—Bayfordbury	2·41	1·04	1·57	·92	·51	2·20	2·82	·86	1·26	1·03	1·93	2·04	18·59	132
Welwyn—The Rectory	2·53	1·16	1·40	1·29	·67	2·29	3·01	1·11	1·73	1·63	1·81	2·53	21·16	158
,, Datchworth	2·38	·77	1·26	1·01	·70	2·06	3·40	1·18	1·42	1·31	1·74	2·17	19·40	132
Stevenage—Bennington	2·11	·58	1·12	·95	·39	2·16	4·19	1·50	1·57	1·38	1·59	2·52	20·06	151
,, Knebworth	2·49	1·22	1·64	1·27	·59	2·19	3·88	1·36	2·15	1·81	1·84	2·59	23·03	136
Buntingford—Throcking.....	2·07	·67	1·07	·97	·39	1·29	3·41	1·91	1·51	1·03	1·65	2·42	18·39	137
Royston—Therfield	1·82	·63	1·06	1·18	·40	1·76	2·57	2·15	1·90	1·64	1·55	1·90	18·56	131
Ware—Fanhams Hall	2·22	·65	1·30	·82	·30	2·55	2·64	1·11	1·66	1·08	1·53	2·08	17·94	...
,, Much Hadham.....	2·28	·83	1·24	1·07	·33	2·16	2·99	1·04	1·79	1·55	1·98	2·22	19·48	139
Hitchin	2·14	·93	1·18	1·33	·55	1·39	3·89	1·76	2·00	1·40	1·92	2·26	20·75	148
,, High Down	2·07	1·26	1·05	1·46	·58	1·57	3·72	1·52	1·82	1·48	·96	2·14	19·63	143
Royston	1·74	·57	·94	1·00	·44	1·27	2·08	2·11	1·59	1·49	1·45	2·00	16·68	120
,, Odsey Grange.....	1·28	·60	·70	·88	·46	1·21	3·16	1·93	1·78	1·37	1·05	1·73	16·15	143
,, Odsey (2nd gauge)..	1·33	·65	·66	·90	·43	1·26	3·21	1·94	1·81	1·43	1·13	1·79	16·54	139
Barley	1·52	·57	·84	1·12	·28	1·17	2·30	1·33	1·58	1·65	1·38	2·05	15·79	136
Mean for the County	2·34	1·07	1·45	1·27	·53	2·16	2·79	1·44	1·76	1·40	1·74	2·68	20·63	141

TABLE III.—SHOWING MEAN MONTHLY FALL IN THE RIVER DISTRICTS.

River District.	January.	Difference from mean 1870-79.	February.	Difference from Mean 1870-79.	March.	Difference from Mean 1870-79.	April.	Difference from Mean 1870-79.	May.	Difference from Mean 1870-79.	June.	Difference from Mean 1870-79.
Thame	3·38	+ ·52	1·58	— ·15	1·95	+ ·24	1·53	— ·65	·62	—1·74	3·15	+ ·91
Colne	2·64	— ·16	1·34	— ·73	1·78	+ ·03	1·55	— ·63	·60	—1·62	2·44	+ ·04
Lea	2·29	— ·11	·92	— ·82	1·35	— ·27	1·05	— ·87	·47	—1·56	2·23	— ·12
Ivel	2·10	— ·12	1·09	— ·50	1·11	— ·37	1·39	— ·56	·56	—1·42	1·48	— ·65
Cam	1·47	— ·49	·60	— ·99	·78	— ·64	·97	— ·71	·40	—1·50	1·23	— ·90

River District.	July.	Difference from Mean 1870-79.	August.	Difference from Mean 1870-79.	September.	Difference from Mean 1870-79.	October.	Difference from Mean 1870-79.	November.	Difference from Mean 1870-79.	December.	Difference from Mean 1870-79.
Thame.....	2·84	=	1·73	—1·03	2·00	— ·76	1·11	—2·07	1·87	—1·09	3·06	+ ·70
Colne	2·43	— ·35	1·43	—1·34	1·88	— ·83	1·43	—1·41	1·90	— ·99	3·23	+ ·94
Lea	3·00	+ ·51	1·27	—1·14	1·62	— ·98	1·35	— ·90	1·79	— ·86	2·44	+ ·36
Ivel	3·80	+1·10	1·64	— ·63	1·91	— ·56	1·44	— ·73	1·44	—1·16	2·20	+ ·15
Cam	2·69	+ ·58	1·83	— ·49	1·69	— ·67	1·48	— ·42	1·25	—1·03	1·89	— ·01

Mean annual fall in 1884 in Thame District 24·82 ins. being 5·12 *below* mean of 1870-79.

,,	,,	,,	Colne	,,	22·65	,,	7.05	,,
,,	,,	,,	Lea	,,	19·78	,,	6·66	,,
,,	,,	,,	Ivel	,,	20·16	,,	5·45	,,
,,	,,	,,	Cam	,,	16·28	,,	7·27	,,

In the minor districts the fall was :—

		in.			in.
Lea ...	Lower Lea	22·14	Thame ...	Upper Thame	24·82
	Upper Lea	19·03	Colne ...	Lower Colne	22·15
	Mimram ...	20·28		Ver	22·98
	Beane ...	21·54		Gade	22·71
	Rib... ...	18·47	Ivel ...	Hiz	20·16
	Ash ...	18·71	Cam ...	Rhee	16·28

This year we find the greatest rainfall in the Thame district, and the least in the Cam. The maximum yearly fall was 24·82 at Tring, being less than the *minimum* of 1880 be it observed; the minimum was 15·79 at Barley. I cannot find any record of so small a yearly fall having previously occurred anywhere in our county, certainly within the last 30 or 40 years, the next smallest fall being 16·62 at Royston in 1864. The maximum monthly fall was 4·19 at Bennington in July, whilst the minimum was 0·28 at Barley in May.

The absolute maximum fall in 24 hours in each month, and the station recording it, was :—

	in.		in.
Jan. 26th—Tring	1·01	July 9th—Hitchin	1·75
Feb. 11th—Southgate ...	0·35	Aug. 9th—Throcking ...	0·94
Mar. 3rd—Gorhambury ...	0·92	Sept. 3rd—Hitchin	0·88
Apl. 6th—Gorhambury ...	0·62	Oct. 9th—High Down ...	0·87
May 12th—Datchworth ...	0·40	Nov. 30th—Moor Park ...	1·05
June 6th—Gorhambury ...	1·58	Dec. 2nd—Gorhambury ...	1·03

The maximum fall of the year was consequently 1·75 at Hitchin on July 9th, which Mr. Lucas describes as a local water-spout. At several other stations the fall was almost as heavy, but it is noticeable that at the neighbouring station of High Down the fall scarcely exceeded half an inch.

The usual analysis of the wettest day has been made with the following result :—

January 23rd at 1 station ; 26th at 26.
February 9th at 4 ; 11th at 5 ; 18th at 1 ; 20th at 1 ; 21st at 11 ; 22nd at 2 ; 23rd at 3.
March 3rd at 25 ; 5th at 1 ; fall on 3rd and 10th equal at 1.
April 6th at 20 ; 27th at 6 ; 6th and 20th equal at 1.
May 2nd at 22 ; 5th at 1 ; 6th at 1 ; 12th at 2 ; 2nd and 12th equal at 1.
June 5th at 15 ; 6th at 10 ; 8th at 1 ; 29th at 1.
July 6th at 4 ; 9th at 13 ; 10th at 5 ; 26th at 2 ; 27th at 2 ; 30th at 1.
August 9th at 6 ; 27th at 20 ; 27th and 31st equal at 1.
September 3rd at all stations.
October 9th at all stations.
November 2nd at 3 ; 5th at 7 ; 30th at 17.
December 2nd at 2 ; 7th at 11 ; 14th at 3 ; 18th at 9 ; 31st at 1 ; 3rd, 14th, and 18th equal at 1.

The wettest day in each month appears to have been :—

Jan.	26th	April	6th	July	9th	Oct.	9th
Feb.	21st	May	2nd	Aug.	27th	Nov.	30th
Mar.	3rd	June	5th	Sept.	3rd	Dec.	7th

The mean number of wet days in each month, and the relation that number bears to the mean of 1870-79, was:—

Jan.	wet days	16	or = the mean.	July	wet days	16	or 3 above mean.
Feb.	,,	13	,, 2 below ,,	Aug.	,,	10	,, 4 below ,,
Mar.	,,	7	,, 7 ,, ,,	Sep.	,,	11	,, 2 ,, ,,
Apr.	,,	13	,, = the mean.	Oct.	,,	9	,, 6 ,, ,,
May	,,	7	,, 6 below ,,	Nov.	,,	12	,, 4 ,, ,,
June	,,	9	,, 5 ,, ,,	Dec.	,,	18	,, 3 above ,,

The mean number of wet days, which was very slightly in excess during the winter season, showed a considerable deficiency in the other three seasons, especially in spring, March and May being considerably below the mean.

I now proceed to review the rainfall statistics for the year as furnished by the 19 observers who have so kindly sent me a record of the daily fall at their respective stations. In doing this I shall endeavour to notice every fall which exceeded $\frac{1}{2}$ an inch, and shall denominate falls exceeding $\frac{1}{2}$ inch as *considerable*; falls exceeding $\frac{3}{4}$ inch as *very considerable*; falls exceeding 1 inch as *great*; falls exceeding $1\frac{1}{4}$ inch as *very great*; falls exceeding $1\frac{1}{2}$ inch as *heavy*; falls exceeding $1\frac{3}{4}$ inch as *very heavy*; and falls exceeding 2 inches as *excessive*.

January.—The weather was unsettled until 8th, from 8th to 21st it was dry, then unsettled again until the end of the month. On the 23rd the fall, which was appreciable at many stations, was *considerable* at Cowroast, 0·70, and at Datchworth, 0·57 On 26th the max. for the month fell at most stations, and the fall was *great* at Tring, 1·01; *very considerable* at Cowroast, 0·87, Ware (Fanhams Hall), and Gorhambury, 0·75; and *considerable* at Bayfordbury, 0·68, Berkhamsted, 0·67, Hitchin and High Down, 0·62, Kensworth, 0·61, Hadham, Nash Mills, Rothamsted, and Watford (Wansford House), 0·60, Great Gaddesden and Moor Park, 0·59, Welwyn, 0·56, Royston, 0·55, Throcking and Ware (N.R.C.), 0·52, Knebworth and Bennington, 0·51, and Therfield, 0·50.

February.—Rain was gauged at all stations on 1st, after which the weather was somewhat unsettled between 8th and 11th, also between 18th and 23rd. Though the fall was on some few days appreciable, it was never at any single station considerable.

March.—The dry weather of the latter part of February lasted until 3rd, when the max. for the month fell at most stations, 8th to 11th were also somewhat unsettled; the fall of the 3rd and 10th comprised the greater part of the fall for the month. The fall of 3rd, which was to some extent snow, was *very considerable* at Gorhambury, 0·92, Tring, 0·87, Berkhamsted and Nash Mills, 0·86, Cowroast, 0·84, and Watford (Wansford House), 0·79; it was *considerable* at Moor Park, 0·71, Rothamsted, 0·68, Knebworth, 0·66, Bayfordbury, 0·65, Ware (Fanhams Hall), 0·61, Great Gaddesden and Watford (Watford House), 0·59, Kensworth, 0·54, Southgate, 0·53, and Ware (N.R.C.), 0·51.

April.—The weather was unsettled until 6th, on which day the

max. occurred at most stations; after this date the weather became dry; slight rain occurred between 13th and 15th, and the 26th and 27th were also wet. On 6th the fall was *considerable* at Tring, 0.61, and Cowroast, 0·50; also on 27th at Rothamsted, 0·60.

May.—Until 7th rain fell nearly every day, after which date scarcely any rain occurred except 0·40 at Datchworth, and nearly ¼ inch at Southgate and Welwyn, on 12th. At Royston rain only fell upon three days, namely, 2nd, 0·38, 5th, 0·04, and 12th, 0·02. The total fall between 3rd of May and 3rd of June at this station was only 0·06 inch.

June.—The dry period which commenced in May lasted until June 4th. The 4th to 9th were unsettled, with noticeable falls on 5th and 6th, the result of thunderstorms; after 9th there was no more rain except on 29th. On 5th the fall was *heavy* at Southgate, 1·56; *very great* at Ware (F. H.), 1·39, *great at* Ware (N.C.R.), 1·22, Tring, 1·21, and Hadham, 1·00; *very considerable* at Kensworth, 0·90, Cowroast, 0·89, Berkhamsted and Therfield, 0·75; and *considerable* at Moor Park, 0·74, Knebworth, 0·72, Wansford House and Welwyn, 0·71, Watford House, 0·70, Rothamsted, 0·67, Nash Mills, 0·64, Great Gaddesden, 0·57, and Bennington, 0·55. On 6th the fall was *heavy* at Gorhambury, 1·58; *great* at Watford (Wansford House), 1·10, (Watford House), 1·09, Rothamsted, 1·04, and Nash Mills, 1·00; *very considerable* at Bayfordbury, 0·95, Southgate, 0·90, Cowroast, 0·83, Welwyn, 0·82, Great Gaddesden, 0·80, Moor Park, 0·79, and Tring, 0·77; and *considerable* at Kensworth, 0·73, Ware (N.R.C.), 0·52, and Hadham, 0·51. It was the only occasion upon which upwards of an inch fell upon two consecutive days, and the 5th and 6th may be regarded as the wettest 48 hours in the year.

July.—The fine weather of June extended to 4th, after which **TSS** constantly unsettled the weather. During **TS** of 6th the fall was *great* at High Down, 1·00; and *considerable* both at Watford (Watford House), 0·66, and Hadham, 0·65. On 9th the fall during **TSS** was *very heavy* at Hitchin, 1·75; *heavy* at Knebworth, 1·73, and at Bennington and Throcking, 1·60; *very great* at Odsey, 1·44, and Datchworth 1·37; *great* at Welwyn, 1·02; *very considerable* at Ware (Fanhams Hall), 0·97, Royston, 0·83, Bayfordbury, 0·81, and Therfield, 0·75; and *considerable* at Barley, 0·71, High Down, 0·56, and Ware (N.R.C.),* 0·51; but *nil* at Moor Park, Nash Mills, Great Gaddesden, and Cowroast. On 10th the fall was *considerable* at High Down, 0·64, Bennington, 0·63, and at Berkhamsted and Tring, 0·52. On 26th there was a *considerable* fall at Bennington, 0·70, and on 30th a *considerable* local fall at Nash Mills, 0·67; all other stations on that day, *nil*.

August.—No rain fell until 9th; from 11th to 24th the weather was dry with slight occasional rain at some stations; after 24th it became unsettled. On 9th during a **TS** the fall was *very considerable* at Throcking, 0·97 (·80 fell in an hour), and Royston, 0·76; *considerable* at Therfield, 0·67, and Tring, 0·62, but *nil* at Southgate, and scarcely appreciable at Welwyn. On 27th, when max.

* There is a considerable discrepancy between the two Ware gauges.

fell at most stations, the fall was *considerable* at Therfield, 0·56, and at Barley and Odsey, 0·51.

September.—Until 8th the weather was somewhat unsettled, after which date except on 21st the fall was occasional and trifling in amount. On 3rd the fall was *very considerable* at Hitchin, 0·88, Tring, 0·82, Berkhamsted, Cowroast, and Great Gaddesden, 0·77; *considerable* at High Down, 0·73, Knebworth and Rothamsted, 0·69, Nash Mills, 0·65, Royston, 0·64, Odsey, 0·62, Southgate, Watford (Wansford House), and Welwyn, 0·60, Watford (Watford House), 0·58, Hadham 0·57, Therfield and Throcking, 0·56, and Gorhambury, 0·50.

October.—Dry except between 8th and 13th, slight falls occurring also after 25th. On 9th, when the max. fell at all stations, the fall was *very considerable* at High Down, 0·87, Knebworth, 0·85 (?), Barley, 0·84, and Hitchin, 0·83; *considerable* at Odsey and Royston, 0·71, Therfield, 0·68, Nash Mills, 0·65, Gorhambury, 0·63, Berkhamsted, 0·62, Datchworth, 0·56, Great Gaddesden, 0·54, Bennington, 0·53, Cowroast, 0·52, and Ware (Fanhams Hall), 0·50.

November.—Unsettled until 9th, small falls between 17th and 21st, and snow storm on 30th. On 5th the fall was *very considerable* at Moor Park, 0·79, and Southgate, 0·75; *considerable* at Watford (Wansford House), 0·72, Watford House, 0·70, Ware (Fanhams Hall), 0·63, and Hadham and Ware (N.R.C.), 0·50. On 30th, when snow fell to the depth of 6 or 8 inches, the fall was *great* at Moor Park, 1·05; *very considerable* at Southgate, 0·93, Nash Mills, 0·86, Hitchin, 0·80, Berkhamsted, 0·76, and Watford (Wansford House), 0·75; *considerable* at Bayfordbury, 0·72, Hadham and Rothamsted, 0·64, Ware (Fanhams Hall), 0·63, Tring, 0·61, Watford (Watford House), 0·59, Datchworth, 0·57, Throcking, 0·56, Welwyn, 0·54, Knebworth, 0·54, Royston, 0·53, and Cowroast, 0·50.

December.—The weather was unsettled until 20th, rain falling very nearly every day though not in large quantities. On 2nd the fall was *great* at Gorhambury, 1·03; *considerable* at Cowroast, 0·56. On 7th the fall was *considerable* at Kensworth, 0·61, Berkhamsted, 0·57, Cowroast and Bennington, 0·53, and Tring, 0·52. On 14th the fall was *considerable* at Moor Park and Southgate 0·51, and Watford (Wansford) House, 0·50. On 18th, when snow fell, the fall was *considerable* at Cowroast, 0·60, Moor Park, 0·57, Great Gaddesden, 0·54, Rothamsted, 0·53, and Tring, 0·51. After 20th scarcely any rain fell.

It will be seen by the above summary of the principal daily falls that at some one or more stations the fall was *very heavy* on one occasion, *heavy* on two, *great* on four, *very considerable* on five, and *considerable* on nine. Thus the fall exceeded half an inch on twenty-one different occasions, *i.e.* two in January, one in March, one in April, two in June, four in July, two in August, two in September, one in October, two in November, and four in December.

XXX.

THE NESTS AND EGGS OF BIRDS.

By Henry Seebohm, F.L.S., F.Z.S.

A Lecture delivered at Watford, 6th January, 1885.

(Abridged.)

If any of you should visit the new Natural History Museum at South Kensington, and should be admitted into the room where the skins of birds are kept, and if you should then watch the curator measuring the legs and toes, counting the tail-feathers, and engaged in other similar work, you would probably arrive at the conclusion that Ornithology was not an attractive pursuit. In this however you would be wrong; the curator is really engaged in a great work: he is attempting to evolve order out of chaos.

The classification of birds is a science yet in its infancy; we have not as yet discovered the lines upon which it will be eventually drawn. The system I propose this evening to follow is a purely artificial one, depending on the relation of birds to their nests and eggs.

I will first refer to a few of those birds which appear to rely for the safety of their eggs on the protective colour of the eggs.

I shall ask you to take a trip with me (in imagination) to the grouse moors near Sheffield, the best district for birds-nesting that I know in England, and where a greater number of rare birds are found to breed than in any other place it has been my good fortune to visit. The moors are a stretch of rolling country, covered with heath, with a few streams and one or two rivers running through them, and scattered over with rocks. They are very strictly preserved by armies of game-keepers. To Englishmen the grouse is a peculiarly interesting bird, inasmuch as it is the only one that is found exclusively in the British Islands. You may see hundreds, I might almost say thousands of these birds breeding on the moors; they make a mere scratch of a nest on the heath, and their eggs are a rich russet-brown colour, sometimes almost shading into a brilliant sepia with a blueish or deep red cast upon it, the object evidently being to render the eggs as inconspicuous as possible by making them almost the same colour as the peat and lichen by which they are surrounded.

Three species of hawks breed upon the moors; they are supposed to feed upon the young grouse, and the grand object of every game-keeper is to keep his moor free from hawks. The most interesting of these hawks is the merlin, a bird in which I have taken the greatest interest, on account of its peculiar habit of nesting. For many years I made an arrangement with a game-keeper to send me a post-card the moment he discovered a merlin's nest upon the moor under his protection. On this moor there is a little bank covered with heath on which the merlin has for several years regularly nested, and yet there is nothing whatever about the spot that would lead you to suppose that it was specially adapted for the

purpose. The nest is exactly like that of the grouse, and the eggs are a rich red colour, very much resembling the red bog so common in the district. For five years I went to this identical bank; I saw the game-keeper shoot or trap both the parent-birds; I took the eggs, or, if they were found to be hatched, we caught the young birds, and yet every year, in the same place, a merlin's nest was found. Of course it could not belong to the same birds, for we had killed them, and there was no other nest within a distance of six miles. I can only suggest the following explanation. It would seem probable that the present breeding-places of the merlin have been maintained for a great number of years, and that the birds have a recognised understanding that no other merlin is allowed to have a nest within the district. As spring approaches, and they migrate from their winter homes in Southern Europe or Northern Africa, they recognise these places; they immediately attempt to seize upon them, and if found already occupied they simply pass on. It is a curious fact that if you shoot one or other of the two birds during the first month, within twenty-four hours the survivor obtains a fresh mate; but if this should occur after the period of migration has closed, the stock of old maids or bachelors has become exhausted, and the poor merlin has to remain without a mate until it is shot.

Further down the valley we leave the moor-birds behind us and come upon some very beautiful specimens of a similar tribe which build in perfectly concealed places, where no eye can possibly see the eggs, and the consequence is that the eggs are a pure white. You may lay it down as a broad rule, without any exception, that all birds, breeding in holes or in nests so covered over that the eggs cannot be seen, have white eggs. A very interesting species under this head is the kingfisher, which, as you know, breeds in this neighbourhood; then there is the water-ouzel which builds a domed nest so completely covered over that you are unable to obtain the slightest glimpse of the eggs; and lastly there is the sand-marten. It is difficult to account for the fact; all one can say is that these birds have never found it necessary to colour their eggs, and that consequently they have not been coloured.

We will now leave the Sheffield moors, and, taking a journey to the coast, will visit a group of islands near Sunderland known as the Fern Islands. Here may be seen an unusually large number of different birds. They are all sea-birds, they breed almost entirely in colonies, and rely, to a very large extent, for the safety of their eggs, on their own ability either singly or in pairs to defend them. On approaching the islands, one of the most interesting objects that attracts your attention is a colony of guillemots; you may observe clouds of birds rising from what are called "the pinnacles," and taking flight into the air, until all around you becomes dense as with a swarm of bees, while streams of birds continually pour from off the rock, taking headers into the sea until the whole surface of the waves is dotted over with them. They are immensely active both in the air and in the water, but the

most remarkable thing about them is the variety and brilliancy of their eggs; the eggs are unusually large, being about the size of a goose-egg, and they are singularly beautiful both in colour and in the arrangement of pattern. Each bird lays but one egg, and she is, in fact, unable to sit upon more.

Now we have just said, when referring to birds which rely for the safety of their eggs on the concealed position of their nests, that Nature had taken no trouble whatever about protective colour, and that the eggs were white. In the case of the guillemot the position is exactly reversed; their eggs are laid upon a perfectly white surface of rock, and one would naturally expect that they too would have been white; but the guillemot being a powerful bird, and its immense numbers enabling it to drive away any hawk that might come to prey upon its eggs, no necessity exists for protective colouring, and Nature appears to have rushed into the opposite extreme, as if to show what wonderful variety of colour and pattern she could produce. It is possible to suggest a further explanation. During the time of incubation guillemots congregate in immense masses on the top of the rocks; supposing that all their eggs were exactly alike, it would be almost impossible for each bird to distinguish her own, and the rocks would be a constant scene of fighting and squabbling, but being of different colours the bird with a green egg (for instance) is able at once to pounce upon it, and the bird with a white egg is able to find her own.

Passing away from the colony of guillemots, we find, in the rocks opposite, little gorges running into the mainland, and on narrow ledges on the sides of these gorges the kittiwake gull builds her nest and rears her young. The eggs are conspicuous and differ much in their colour and markings, but the nests are so inaccessible that most of the eggs are successfully reared.

We proceed onwards; on a neighbouring island the land slopes gradually almost to the level of the sea, and is covered with small marine vegetation of various kinds. It is about half a mile long, and is one vast colony of herring-gulls and of the lesser black-backed gull. The scene as you approach is one of great beauty; you may perhaps see as many as 10,000 gulls, with snow-white breasts, standing head to wind, like so many weather-cocks, while thousands of others are flying around you on every side. Beyond the island is a stretch of shingle, by following which you approach a large sand-bank. The sand is the colour of ordinary grey sand, without a bit of vegetation on it, but interspersed with small black and white stones, which give to it rather a rich appearance. In one portion of the sand-bank the gravel is larger than elsewhere, and this spot supplies a home to a colony of sandwich-terns. I believe that I am correct in saying that it is impossible to cross this sand without treading upon terns' eggs. The colour of the eggs exactly resembles the colour of the sand and gravel on which they are deposited, and, unless the greatest possible care is taken, you are perfectly certain to crush some of them. The sandwich-tern affords a very striking example of the class of birds which

solely rely for the protection of their eggs on their protective colouring. On the edge of the sand, where the sea washes up, there are colonies both of the arctic and the common tern; the eggs of these birds are darker than those of the sandwich-tern, and are evidently so coloured that when lying on the delicate seaweed they may be almost as inconspicuous as the sea-weed itself.

On another island of the same group a very different style of nest-building is met with. This island is covered with turf, and a colony of puffins breed at the end of the rabbit-burrows which everywhere abound. The eggs are slightly spotted. You can see the spots when the egg is washed and clean. It is probable that in past ages the puffin laid its eggs in an open nest, and that then they were distinctly spotted; now that it adopts a rabbit-burrow, where no light can penetrate, the colouring-matter has been gradually lost, and, unless the bird becomes extinct, they will eventually become as white as the eggs of other birds whose habit it is to breed in holes. It is difficult to say why the colour should be lost in cases of this kind where no protective selection can take place; but it seems to be a law in nature that any organ, which is not necessary for the use of an animal, becomes in consequence of disuse more and more rudimentary, until it almost ceases to be considered an organ at all, and that the converse proposition is equally true. In other words, that organs increase and strengthen by use and decrease by absence of use. Take as an example a bird very nearly allied to the guillemot—the great auk. It is only about forty years since the last great auk was seen, and yet specimens of this bird are now worth £500 each, and its eggs, more or less damaged, were recently sold by auction in London for 100 guineas and 105 guineas each. It was completely unable to fly; it had a wing, but it was only four or five inches long, and in consequence of not having been used for many generations, it became of so rudimentary a character that it was practically useless. The case of the great auk may be accepted as an illustration, not certainly of the survival of the fittest, but of the extinction of the most unfit.

We must not dwell longer on the interesting Fern Islands, but will imagine ourselves transported to the wilds of the Siberian tundra, beyond the limits of forest-growth, into a district of mosses, bogs, and swamps, of rivers and lakes, everything except trees, there not being a single tree within a thousand miles. You may think that places such as this, covered during eight months of the year six feet deep in snow, could hardly be good for birds-nesting; but I must inform you that what is called in Siberia a tundra, and in England a moor, is one of the great bird-nurseries of the world. Here you may find hundreds of birds which visit the coasts of England during the winter: sandpipers, different kinds of geese, ducks, swans, and many others, all content enough to spend the winter months in the south, but invariably retreating in the spring for breeding purposes to the wild Arctic regions in the north of Europe.

The summer in northern Siberia is very short; for three months the sun never sets; there are twenty-four hours of sunshine every

day. The whole surface of the country, like an English garden run wild, is brilliant with flowers—anemones, pinks, gentians, and saxifrages, in full bloom. Arctic fruits abound everywhere. Strawberries, crowberries, bilberries, and various other fruits ripen rapidly during the hot summer, and almost as soon as they are ripe are covered up in a thick bed of snow. The snow freezes and preserves them during the long winter months, and directly it melts there is an abundant store of last year's fruit ready for the multitudes of birds to eat directly they arrive. Birds which feed upon insects are provided for in an equally liberal manner. Mosquitoes by millions and ten of millions cover the open tundra. It is impossible to form any conception of the millions that spread over the country. The Arctic blue-throat, the willow-warbler, the Siberian chiff-chaff, and other delicate birds, all feed upon mosquitoes, and here find a congenial home. Of all the many birds which breed upon the Siberian tundra, swans, ducks, and geese are probably the most conspicuous; while the grey plover, the little stint, and one or two other birds whose breeding-places were, until recently, absolutely unknown, are certainly the most interesting. I first visited Siberia in 1875 with my friend Mr. Harvie Brown, and we had the good fortune to find the eggs both of the grey plover and the little stint, neither of which were then known to be in any European collection, with the single exception of the Museum at St. Petersburgh. Twelve or fourteen distinct species of ducks and geese breed upon the tundra, and it was very interesting to see how carefully the nests of many of them were covered over by the parent-birds with down plucked from off their own breasts, forming a sort of lining which was pulled over the eggs whenever they were left, and affording not only concealment during absence, but also acting as a protection against cold.

And now I will ask you to leave the far north and go with me to visit the colonies of the birds which are to be found in the south of Europe. Before doing so I will briefly allude to a class of birds which rely for the safety of their eggs upon the protective colour of the sitting hen. Of this class you cannot have a better example than the common pheasant; the cock is an extremely brilliant bird, but the hen is a plain brown creature, and, when sitting, is very inconspicuous, and consequently comparatively safe.

The summer before last I went down the Danube for the purpose of visiting the breeding-places of the various waders, and conspicuous among these is the common heron. The heron is an early breeder, but on the Danube no eggs are to be found until May or June. The Danube is a river very similar to the Nile. When the snow on the Carpathians and the Alps begins to melt, it rises rapidly, and twenty miles of the country on its northern side is laid under water. The herons on the Danube never begin to nest until there is about six feet of water in the forests; they have learned by experience, or natural selection may have eliminated the birds that do not know, that it is only safe for them to make their nests where neither rats, weasels, nor boys can molest or rob them.

The most interesting colony visited lies to the north-west of the Dobrudscha—a country of vast steppes one hundred or one hundred and fifty feet above the level of the Danube. On these steppes there are no trees, and nothing but a line of telegraph posts and wires that stretches from one horizon to the other, to relieve the monotony of the prospect. We had camped out all night in our wagon, and had watched the breeding-habits of the bustard, the largest European bird. It is very curious that the larger the bird is, the more shy he is generally found to be; but instead of hiding himself in forests, the bustard chooses a perfectly bare plain over which he can see for several miles, and directly an intruder comes within range, he takes flight inland. On reaching the Danube, we met a man who offered to conduct us to a colony of herons. It was a somewhat difficult undertaking; we found that it was necessary to cross an arm of the Danube, then to make our way through a long lane of water, covered with beautiful white lilies, and next to force a passage through vast quantities of reeds and rushes, where black terns and various species of ducks breed in colonies. Occasionally we drifted along with the current under overhanging willows, and once or twice were compelled to drag our boat over the dry land; at last we reached an open pool or lake, on the further side of which was an enormous forest of pollard-willows. In the midst of this forest we came upon the herons; the colony had taken possession of about 400 trees, and each tree contained from 10 to 25 nests, which comprised five different species. The trunks of the willows were about six to eight feet high, and then broke out into a dense mass of small branches; on the centre stump, in the most conspicuous and strongest place, was generally to be found a huge nest of the common heron, containing perfectly fresh eggs; next came the night heron, somewhat similar in colour, but about half the size; then the little egret, as white as snow; next the squacco heron, also white but with patches of buff and black upon the back; and among other species was the cormorant. These five species were constantly found nesting on the same tree. As we approached the colony, some of the birds became alarmed, and it was wonderful to listen to the rush of wings as they got up and flew away. It was an intensely hot day, the thermometer standing at 90° or 95°, and consequent upon the droppings of such an enormous multitude of birds, the whole place reminded one of a fowl-house. It was literally all guano. As we disturbed clump after clump, the noise became more and more unearthly, for herons have no idea of music, and the whole scene was one I shall never forget. In thousands of miles of travelling, it was one of the most interesting sights that I have ever seen.

But the subject is inexhaustible, and I must therefore bring it to a close with this description of the waders of the Danube.

XXXI.

LIST OF LEPIDOPTERA OBSERVED IN THE NEIGHBOURHOOD OF HITCHIN AND AT KNEBWORTH, HERTS.

By John Hartley Durrant, F.E.S.

(*Communicated by* A. F. Griffith, M.A.)

Read at Watford, 24th March, 1885.

The Lepidoptera enumerated in the first of the two following lists have been collected at Hitchin, and at Hitch Wood, Ickleford, Norton (near Baldock), Offley, Pegsdon, St. Ippolyts, and Tingley Wood, in the vicinity of Hitchin; and those in the second at Knebworth. Taken roughly, all my collecting has been done on the Chalk, or on the Boulder-clay or Drift overlying it. I record 419 species, of which 106 are not included in Mr. Griffith's list,* consequently raising the County list from 514 to 620. I am greatly indebted to Mr. W. Hill, jun., for species taken at Hitchin and Knebworth, and for assistance in compiling this list.

Lepidoptera observed in the Neighbourhood of Hitchin.

RHOPALOCERA.

Diurni.

Pieris
brassicæ
rapæ
napi
Anthocharis
cardamines
Gonepteryx
rhamni
Colias
Edusa
Hyale
Argynnis
Paphia
Euphrosyne

Vanessa
urticæ
polychloros
Io
Atalanta
cardui
Satyrus
Megæra
Janira
Tithonus
Hyperanthus
Chortobius
Pamphilus

Thecla
quercus
Polyommatus
Phlæas
Lycæna
Agestis
Alexis
Alsus
Thanaos
Tages
Hesperia
Sylvanus
linea

HETEROCERA.

Nocturni.

Smerinthus
ocellatus
populi
tiliæ
Acherontia
Atropos
Sphinx
convolvuli
ligustri
Chærocampa
porcellus
Elpenor
Macroglossa
stellatarum

Sesia
tipuliformis
formiciformis
bembeciformis
Zeuzera
æsculi
Cossus
ligniperda
Hepialus
hectus
lupulinus
sylvinus
Velleda
humuli

Procris
Geryon
Zygæna
trifolii
filipendulæ
Nola
cucullatella
Lithosia
complanula
griseola
Euchelia
jacobææ
Callimorpha
dominula †

* See p. 58.

† One specimen, in 1872.

NOCTURNI—*continued.*

Chelonia
Caja
Arctia
mendica
lubricipeda
menthastri
Liparis
auriflua
salicis
Psilura
monacha
Orgyia
pudibunda
antiqua
Trichiura
cratægi
Pœcilocampa
populi
Bombyx
Neustria
quercus
Odonestis
potatoria
Lasiocampa
quercifolia
Saturnia
carpini

GEOMETRINA.

Uropteryx
sambucata
Epione
apiciaria
Rumia
cratægata
Metrocampa
margaritata
Ellopia
fasciaria
Eurymene
dolabraria
Pericallia
syringaria
Selenia
illunaria
Odontopera
bidentata
Crocallis
elinguaria
Ennomos
tiliaria
fuscantaria
Himera
pennaria
Phigalia
pilosaria
Biston
hirtaria
Amphidasis
prodromaria
betularia
Hemerophila
abruptaria
Boarmia
repandata
rhomboidaria
Iodis
vernaria
lactearia
Hemithea
thymiaria
Asthena
luteata
candidata
Acidalia
bisetata
scutulata
Acidalia
incanaria
imitaria
aversata
Timandra
amataria
Cabera
pusaria
exanthemaria
Corycia
taminata
Halia
Wavaria
Strenia
clathrata
Fidonia
atomaria
piniaria
Abraxas
grossulariata
Lomaspilis
marginata
Hybernia
rupicapraria
aurantiaria
progemmaria
defoliaria
Anisopteryx
æscularia
Cheimatobia
brumata
Oporabia
dilutata
Larentia
didymata
multistrigaria
pectinitaria
Emmelesia
decolorata
Eupithecia
linariata
centaureata
succenturiata
subfulvata
castigata
albipunctata
vulgata
Eupithecia
absynthiata
assimilata
exiguata
sobrinata
coronata
rectangulata
Ypsipetes
elutata
Melanthia
ocellata
Melanippe
rivata
subtristata
montanata
fluctuata
Anticlea
badiata
derivata
Coremia
ferrugata
unidentaria
quadrifasciaria
Camptogramma
bilineata
Phibalapteryx
lignata
tersata
Scotosia
dubitata
vetulata
rhamnata
Cidaria
miata
russata
immanata
testata
fulvata
pyraliata
dotata
Eubolia
cervinata
mensuraria
palumbaria
bipunctata
Anaitis
plagiata

Pseudo-bombyces.

Cilix
spinula
Dicranura
furcula
bifida
vinula
Pygæra
bucephala
Ptilodontis
palpina
Notodonta
camelina
dictæa
Notodonta
dictæoides
dromedarius
ziczac
Diloba
cæruleocephala

Noctuina.

Thyatira
derasa
Cymatophora
duplaris
Bryophila
Perla
Acronycta
tridens
psi
megacephala
aceris
rumicis
Leucania
conigera
lithargyria
comma
impura
pallens
Nonagria
fulva
lutosa
Gortyna
flavago
Hydræcia
nictitans
micacea
Axylia
putris
Xylophasia
rurea
lithoxylea
sublustris
polyodon
Heliophobus
popularis
Luperina
testacea
Mamestra
anceps
brassicæ
persicariæ
Apamea
gemina
oculea
Miana
strigilis
fasciuncula
furuncula
Miana
arcuosa
Grammesia
trilinea
Caradrina
Morpheus
cubicularis
Rusina
tenebrosa
Agrotis
segetum
exclamationis
nigricans
tritici
ravida
Triphæna
janthina
interjecta
orbona
pronuba
Noctua
augur
plecta
C-nigrum
triangulum
rubi
xanthographa
Tæniocampa
gothica
rubricosa
instabilis
stabilis
gracilis
cruda
Orthosia
lota
Anchocelis
pistacina
litura
Xanthia
silago
ferruginea
Tethea
subtusa
Cosmia
trapezina
diffinis
affinis
Dianthœcia
conspersa
Hecatera
serena
Polia
flavocincta
Miselia
oxyacanthæ
Agriopis
aprilina
Phlogophora
meticulosa
Aplecta
nebulosa
Hadena
oleracea
pisi
Xylocampa
lithoriza
Cucullia
verbasci
umbratica
Heliothis
marginata
peltigera*
Heliodes
arbuti
Abrostola
urticæ
triplasia
Plusia
chrysitis
iota
gamma
Gonoptera
libatrix
Amphipyra
tragopogonis
Mania
maura
typica
Catocala
nupta
Euclidia
Mi
glyphica

* One specimen, in 1884.

Deltoidæ.

Hypena
proboscidalis
rostralis

Rivula
sericealis

Herminia
barbalis
tarsipennalis

Pyralidina.

Pyralis
farinalis
Aglossa
pinguinalis
Pyrausta
purpuralis
Herbula
cespitalis
Cataclysta
lemnalis

Hydrocampa
nymphæalis
Botys
verticalis
urticalis
Ebulea
sambucalis
Pionea
forficalis

Scopula
lutealis
olivalis
prunalis
Stenopteryx
hybridalis
Scoparia
dubitalis
mercurella

Crambites.

Crambus
pratellus
pascuellus
pinetellus
perlellus
tristellus

Crambus
geniculeus
culmellus
hortuellus
Phycis
roborella

Galleria
mellonella
Melia
sociella
Meliphora
alveariella

Tortricina.

Halias
prasinana
quercana
Tortrix
pyrastrana
rosana
heparana
ribeana
cerasana *
viridana
ministrana
adjunctana
Peronea
favillaceana
variegana
Peronea
aspersana
Shepherdana
Teras
caudana
contaminana
Dictyopteryx
Holmiana
Bergmanniana
Forskaleana
Argyrotoxa
Conwayana

Penthina
cynosbana
ochroleucana
Spilonota
suffusana
roborana
Pardia
tripunctana
Sericoris
bifasciana
lacunana
Phtheochroa
rugosana
Sciaphila
virgaureana
communana
hybridana
Capua
ochraceana
Bactra
lanceolana
Grapholitha
trimaculana
Penkleriana
Batodes
angustiorana

Ephippiphora
cirsiana
Brunnichiana
trigeminana
Retinia
pinivorana
pinicolana
Carpocapsa
pomonana
Stigmonota
perlepidana
regiana
Dicrorampha
Petiverana
ulicana
Catoptria
Scopoliana
Xylopoda
Fabriciana
Chrosis
tesserana
Xanthosetia
hamana
Tortricodes
hyemana

Tineina.

Cheimabacche
fagella
Tinea
rusticella
tapetzella

Tinea
cloacella
lapella
biselliella

Nemophora
Schwartziella
Swammerdamia
comptella
cæsiella

* This is, I believe, usually considered a variety of *ribeana*.—(A. F. G.)

TINEINA—*continued.*

Hypomoneuta
padellus
Plutella
cruciferarum
Cerostoma
radiatella
Enicostoma
lobella
Phibalocera
quercana
Depressaria
liturella
arenella
propinquella
subpropinquella
Alstrœmeriana
applana
Gelechia
affinis
Œcophora
pseudospretella
Endrosis
fenestrella
Perittia
obscurepunctella
Argyresthia
nitidella
Gædartella
Brockeella
Cedestis
farinatella
Gracillaria
stigmatella
syringella
Coriscium
Brongniartellum
Ornix
avellanella
torquilella
Coleophora
lineolea
Laverna
epilobiella
Elachista
nigrella
rufocinerea
cygnipennella
Tischeria
complanella
Lithocolletis
ulmifoliella
coryli
quercifoliella
tristrigella
Phyllocnistis
suffusella
saligna
Cemiostoma
laburnella

PTEROPHORINA.

Pterophorus
bipunctidactylus
pterodactylus
Pterophorus
microdactylus
pentadactylus
Alucita
polydactyla

Lepidoptera observed at Knebworth.

RHOPALOCERA.

Melitæa
Artemis
Thecla
W-album
Syrichthus
alveolus

HETEROCERA.

NOCTURNI.

Trochilium
bembeciforme
Procris
statices
Calligenia
miniata
Lithosia
mesomella
Psilura
monacha
Pœcilocampa
populi

GEOMETRINA.

Pseudoterpna Cytisaria.

NOCTUINA.

Thyatira
Batis
Cymatophora
Or
diluta
Leucania
turca
Gortyna
flavago
Rusina
tenebrosa
Noctua
plecta
Scopelosoma
satellitia
Erastria
fuscula
Amphipyra
pyramidea
Toxocampa
pastinum
Euclidia
glyphica

APPENDIX.

Notes on Mr. Durrant's List of Lepidoptera.

By A. F. Griffith, M.A.

Mr. Durrant has kindly supplied me with information as to a few species included in the above lists which he has not obtained himself.

Sesia formiciformis.—Two specimens taken by Mr. Christian at Norton near Baldock.

Toxocampa pastinum.—Caught at Knebworth by Mr. Benjamin Brown, formerly of Deard's End Farm.

Calligenia miniata.—Caught at Knebworth, also by Mr. Benjamin Brown.

Melitæa Artemis.—Taken at Knebworth Wood, by Mr. B. Christian, two or three years ago.

The first two of these species might perhaps be expected to occur here, as they are found in the adjoining county of Cambridge, in the fens. Knowing, however, as I do, how easily any one forgets the exact locality of insects placed in his collection, unless a note of it is made at the time, I should feel disposed to ask for further information as to them before finally admitting them as distinguished members of our County List. If any member of our Society should be in the neighbourhood of Baldock or Knebworth about the middle or end of June, and would examine the dead twigs of sallow or osier for the pupa of *S. formiciformis*, which is concealed in a burrow within, and would also, just before dark, watch the marshy spots where *Vicia Cracca* grows, for the large pale *T. pastinum*, he will very possibly have the satisfaction of confirming these two very interesting additions to our list.

The last two of these species, with *Erastria fuscula*, are new to our list, and are also very interesting additions, and this prolific neighbourhood is certainly worthy of a careful examination.

I may add that lists, including a considerable number of species new to our County records, have been received from Mr. F. J. H. Jenkinson (of insects taken in the neighbourhood of Berkhamsted), Mr. B. Piffard of Hemel Hempstead, Mr. A. E. Gibbs and Mr. A. Lewis of St. Albans, and Mr. Horley of Hoddesdon. A tabulated list of these will, it is hoped, shortly appear in our 'Transactions,' and I hope before then to receive further contributions.

INDEX.

A.

Acclimatization of food-fishes, xlix.
Address, Anniversary, 1884, xxii ; 1885, 157.
Albino sports, 216.
Albury, well-section at, 173.
Aldbury visited, xl, lxii ; mosses of, lxiii ; twite caught near, 82.
Aldbury Owers visited, xl, lxii ; plants and land-mollusca of, xl ; *Anemone pulsatilla* at, lxii.
Aldenham House, well-section at, 173.
Altitudes, xi.
Ampelis garrulus in Herts, 208.
Amwell, visited, lxviii ; Izaak Walton at, lxix.
Amwell Hill, British encampment on, lxix.
Ancient Britons, coinage of, and natural selection, xxiii.
Andrews, R. T., phenological observations by, in 1883, 191 ; in 1884, 228.
Anniversary Address, 1884, xxii ; 1885, 157.
Anniversary meeting, report of, 1884, xv ; 1885, liii.
Annulosa of the Chalk, 149.
Anthomyia brassicæ, *radicum*, and *floralis*, attack of, in Herts, 93.
Ants, observations on, 161.
Ardetta minuta in Herts, 209.
Arionidæ, 18, 21 ; of Herts, 27, 31.
Ashlands, Watford, visited, lxxi.
Ashridge Park visited, lxii ; mosses of, lxiii.
Ashwell, boulders of, 34, 39 ; microscopic structure of doleritic boulders from, 47 ; of basaltic, 50 ; of porphyritic, 51 ; of granitic, 52 ; of schistose, 54.
Auk, little, in Herts, 216.
Aviary, singular occurrence in, 89.

B.

Balance-sheet for 1883, xxi ; for 1884, lvii.
Baldock, Lepidoptera of, 261, 266.
Barley, rainfall at, in 1883, 115 ; in 1884, 249.
Barnet, well-section at, 174, 175.
Barnet, East, rainfall at, in 1883, 115 ; in 1884, 249.
Basalts, microscopic structure of boulders of, 50.
Bayfordbury, Hertford, rainfall at, in 1883, 115 ; in 1884, 249.
Bees, observations on, 162.
Berkhamsted, rainfall at, in 1883, 115 ; in 1884, 249.
Birds observed in 1883, 82 ; in 1884, 207 ; nests and eggs of, 255.
Bishop's Stortford, well-section at, 175.
Bittern, little, in Herts, 209.
Boulder-clay in North Herts, 33.
Boulders in North Herts, 33 ; list of, 43 ; igneous, of North Herts, tabular view of, 55.
Braithwaite, Dr. R., list of mosses found at Gorhambury by, xlviii.
Brett, Dr. A. T. : List of Land and Fresh-water Mollusca observed in Hertfordshire, xiv, 29-32 ; Notes on some Scolecida (title only), xxxvii ; On the Poisonous Effects of the Common Yew, xxxvii-xxxviii.
Bricket Wood visited, lxxi ; lichens and mosses of, lxxii.
Brocket Hall, Hatfield, rainfall at, in 1883, 115 ; in 1884, 249.
Broxbourne, well-section at, 180.
Buntingford, boulders near, 42 ; rainfall at, in 1883, 115 ; in 1884, 249 ; earthquake felt at, 246.
Buzzard, rough-legged, in Herts, 210.
Bygrave, boulder-clay at, 39, 40.

C.

Cam district, rainfall in, in 1883, 116; in 1884, 250
Campbell, F. M.: On Instinct, xxxix, 119-142; On Spiders (title only), xlix.
Carychiidæ, 18, 23; of Herts, 28, 32.
Cassiobury Park visited, lxx.
Cephalopoda of the Chalk, 149.
Chaffinch in Herts, 213.
Chalk, of Herts, xlii; near Hertford, lxvi; its origin and constitution, 143; range, 143; extent, 145; extraneous materials, 147; organic remains, 149.
Chalk-marl, 144.
Chalk-rock, 144, 146.
Chambers, W. O.: The Acclimatization of Food-Fishes, xlix-li.
Chandler's Green, well-section at, 178.
Cheneys visited, lxiv.
Cheshunt, well-section at, 176.
Chough in Herts, 208.
Circus cyaneus in Herts, 83.
Clay Bush Hill, height of, 36; pit-section at, 37; boulders and pebbles from, 37.
Cloud at Throcking, in 1883, 105; in 1884, 241; at Watford, in 1883, 185; in 1884, 221.
Coccoliths of the Chalk, 154.
Codonosigidæ of Herts, 97.
Coinage of the Ancient Britons and Natural Selection, xxiii.
Colne, grayling in, li.
Collared monads, 96.
Colne district, rainfall in, in 1883, 116; in 1884, 250.
Colymbus glacialis in Herts, 209.
Conchifera of Herts, 29; of the Chalk, 149.
Conglomerate, Herts, at Newberries, Radlett, xlii.
Cooke, M. C., list of fungi found at Gorhambury by, xlviii.
Coot in Herts, 215.
Corals of the Chalk, 150.
Cordeaux, J., on the pied wagtail, 87.
Council elected 19th Feb. 1884, xvi; 17th Feb. 1885, liii.
Council Report for 1883, xvi; for 1884, liii.
Cowper, Earl: Anniversary Address, delivered 17th Feb. 1885, liii, 157-164.
Cowroast, Tring, rainfall at, in 1883, 115; in 1884, 249.
Cretaceous formations, order of succession of, 144.
Crinoids of the Chalk, 149.
Croft, R. B., phenological observations by, in 1883, 191; in 1884, 228.
Cryptogamic meetings, reports of, 1884, xlvii; 1885, lxii, lxxi.
Cussans, J. E., quoted, lxv, lxix.
Cyclostomatidæ, 18, 23; of Herts, 28, 32.

D.

Dabchick in Herts, 88, 215.
Darwin, C., on neuter insects, 127.
Datchworth, rainfall at, in 1883, 115; in 1884, 249.
Death, feigning, 128.
Diatomaceæ, 1; list of species found near Hertford, 9; their nature and habits, 197; list of species found in Herts, 206.
Digswell, hoopoe shot near, 82.
Direction, sense of, 136.
Discostomata of Herts, 95.
Diver, great northern, in Herts, 209.
Dolerites, microscopic structure of boulders of, 47.
Donations to the Library in 1883, xxxiv; in 1884, lviii.
Dotterel in Herts, 84.
Dotterel's day, 84.
Duck tufted, in Herts, 216.
Durrant, J. H.: List of Lepidoptera observed in the Neighbourhood of Hitchin and at Knebworth, Herts, lxii, 261-266.

E.

Earthquake of 22nd April, 1884, felt in Herts, 246.
Easneye Park visited, lxx.
Echinoderms of the Chalk, 149, 150.
Eggs and nests of birds, 255.
Elsden, J. V.: On the Microscopic Structure of Boulders found in the North of Hertfordshire, xv, 47-57.
Elstree, well-section near, 173.
Eocene beds near Hertford, lxvi.
Essendon Place, well-section at, 176.
Eudromias Morinellus in Herts, 84.
Evans, Dr. J.: Anniversary Address, on the Coinage of the Ancient Britons and Natural Selection, delivered 19th Feb. 1884, xxii-xxxiv.
Exchange, books received in, in 1883, xxxv; in 1884, lviii.
Expenditure and receipts, 1875-84, xx; in 1883, xxi; in 1884, lvii.

F.

Fanhams Hall, Ware, visited, xlvii; rainfall at, in 1883, 115; in 1884, 249; well-section at, 179; phenological observations at, in 1883, 191; in 1884, 228.
Fayrer, Sir J.: Our Serpent-foes in India (title only), xlix; Indian Snakes and Snake-charming (title only), lii.
Field Meetings, reports of, 1884, April 19, Park Street and Frogmore, xxxviii; May 31, Rickmansworth Common Moor and Moor Park, xxxix; June 7, Aldbury Owers, Tring, xl; June 21, Leavesden Woods, Watford, xli; July 12, Radlett and Battler's Green, xli; July 17, Widford, xlvi; November 1, Verulam Woods and Gorhambury Park, St. Albans, xlvii.——1885, March 26, Aldbury and Ashridge Park, lxii; April 11, Rickmansworth, Cheneys, and Flaunden, lxiv; May 16, Hertford and Ware, lxv; June 20, Cassiobury Park, Watford, lxx; October 17, Bricket Wood, lxxi.
Fire-crest in Herts, 207.
Fishes, acclimatization of, xlix; of the Chalk, 149.
Flaunden visited, lxiv; old church of, lxiv.
Flint, origin and composition of, 154.
Flood-marks, xi.
Fordham, H. G.: Notes on Boulders and Boulder-clay in North Hertfordshire, xv, 33-46; phenological observations by, in 1883, 191; in 1884, 228.
Forecasts, xii.
Fragilus graculus in Herts, 208.
Frogmore, St. Albans, visited, xxxviii.
Fungi of Verulam Woods and Gorhambury Park, St. Albans, xlviii.

G.

Gaddesden, Great, rainfall at, in 1883, 115; in 1884, 249.
Gade, grayling in, li.
Galleria cereana, attack of, in Herts, 94.
Gannet in Herts, 210.
Gargany in Herts, 210.
Gastropoda, 17; of Herts, 30; of the Chalk, 149.
Gault, 144.
Geology of neighbourhood of Radlett, xlii; of Hertford, lxvii; of Herts, list of works on, 1874-83, 165.
Gibbs, A. E.: Notes on Mosses; with a preliminary Hertfordshire Moss-Flora, xxxvii, 67-81; insects observed in Herts by, 92, 94; plants observed in Herts by, 101.
Gneiss, microscopic structure of boulders of, 53.
Goldfinch in Herts, 87.
Gorhambury Park, St. Albans, visited, xlvii; fungi and mosses of, xlviii; rainfall at, in 1883, 115; in 1884, 249.
Granites, microscopic structure of boulders of, 52.
Grayling in the Colne and Gade, li.
Great Gaddesden, *see* Gaddesden.
Grebe, dusky, in Herts, 215.
Greensand, 144.
Green Tye, Much Hadham, well-section at, 177.
Griffith, A. F.: Notes on Lepidoptera observed in the Neighbourhood of Sandridge, Herts, xxxvii, 58-66; plants observed in Herts by, 101; Notes on Mr. Durrant's List of Lepidoptera, 266.
Griffith, W. S. A.: List of Land and Fresh-water Mollusca observed in Hertfordshire, xiv, 29-32.
Grits, boulders of, in North Herts, 44.
Gullett Wood, Leavesden, visited, xli.

H.

Hadham, Little, well-section at, 176.
Hadham, Much, rainfall at, in 1883, 115; in 1884, 249; well-section at, 177.
Hail, x.
Harlow, well-section near, 177.
Harpenden, rainfall at, in 1883, 115; in 1884, 249; phenological observations at, in 1883, 191; in 1884, 228.
Harvey, Rev. C. W.: Meteorological Observations taken at Throcking, Herts, during the year 1883, xxxix, 103-111; Report on the Rainfall in Hertfordshire in 1883, xxxix, 112-118; Meteorological Observations taken at Throcking, Herts, during the year 1884, lxv, 239-246; Report on the Rainfall in Hertfordshire in 1884, lxv, 247-254.
Hatfield, rainfall at, in 1883, 115; well-section near, 177.
Helicidæ, 18, 21; of Herts, 27, 31.
Hemel Hempstead, rainfall at, in 1883, 115; in 1884, 249.
Hen-harrier in Herts, 83.

Heron in Herts, 215.
Hertford, ordinary meetings at, 1883, xiv ; 1884, xv, xxxvi, xxxix, xlix ; 1885, lx, lxv ; field meeting at, 1885, lxv ; chalk near, lxvi ; Woolwich and Reading Beds near, lxvi ; London Clay near, lxvi ; Diatomaceæ of, 9 ; *Codosiga botrytis* in pond near, 98 ; *Salpingœca tuba* in ditch near, 100 ; rainfall at, in 1883, 115 ; in 1884, 249 ; phenological observations at, in 1883, 191 ; in 1884, 228.
Hertford Castle visited, lxvi.
Hertford Heath, *Salpingœca fusiformis* at, 99.
Hertfordshire, land and fresh-water Mollusca recorded in, 10 ; investigation of land Mollusca in, 17 ; land and fresh-water Mollusca observed in, 29 ; boulders and boulder-clay in, 33 ; microscopic structure of boulders from, 47 ; tabular view of igneous boulders of, 55 ; Lepidoptera of, 58, 261 ; birds observed in, in 1883, 82 ; in 1884, 207 ; insects observed in, in 1883, 91 ; in 1884, 233 ; Protozoa of, 95 ; flowering plants observed in, in 1883, 101 ; rainfall in, in 1883, 112 ; in 1884, 247 ; list of works on geology of, 1874-83, 165 ; well-sections in, 173 ; phenological phenomena observed in, in 1883, 191 ; in 1884, 227 ; diatoms of, 206 ; earthquake of 22nd April, 1884, felt in, 246.
Hertfordshire conglomerate, xlii ; fungi, xlviii ; lichens, lxiii, lxxii ; mosses, xlviii, lxiii, lxxii ; Hepaticæ, xlviii, lxiv, lxxii.
High Down, Hitchin, rainfall at, in 1883, 115 ; in 1884, 249.
High Wych, Sawbridgeworth, phenological observations at, in 1883, 191 ; in 1884, 228.
Hitchin, ordinary meeting at, 1884, xlix ; boulders at, 42 ; microscopic structure of doleritic boulders from, 49 ; of gneissic, 54 ; rainfall at, in 1883, 115 ; in 1884, 249 ; phenological observations at, in 1883, 191 ; in 1884, 228 ; Lepidoptera of, 261.
Hitchin Natural History Club, phenological observations by, in 1883, 191 ; in 1884, 228.
Hoddesdon, rainfall at, in 1883, 115.
Holmes, E. M., list of mosses found at Ashridge by, lxiii ; list of lichens and mosses found at Gorhambury by, lxxii.
Hoopoe in Herts, 82.
Hopkinson, J. : Remarks on the Land Mollusca, with reference to their investigation in Hertfordshire, xiv, 17-28 ; List of Land and Fresh-water Mollusca observed in Hertfordshire, xiv, 29-32 ; plants observed in Herts by, 101 ; List of Works on the Geology of Hertfordshire, 1874-83, lx, 165-172 ; Meteorological Observations taken at Wansford House, Watford, during the year 1883, lxi, 181-190 ; Report on Phenological Phenomena observed in Hertfordshire during the year 1883, lxi, 191-196 ; Meteorological Observations taken at Wansford House, Watford, during the year 1884, lxi, 219-226 ; Report on Phenological Phenomena observed in Hertfordshire during the year 1884, lxi, 227-232.
Hopkinson, Mrs. J., phenological observations by, in 1883, 191 ; in 1884, 228.
Humbert, S., notice of, xvi.
Humidity at Throcking, in 1883, 104 ; in 1884, 240 ; at Watford, in 1883, 184 ; in 1884, 220.
Hydrochelidon nigra in Herts, 209.

I.

Igneous rocks, boulders of, in North Herts, 46.
Income and expenditure in 1883, xxi ; in 1884, lvii.
Insects observed in Herts in 1883, 91 ; in 1884, 233.
Instinct, 119 ; definition of, 121 ; relation of evolution to, 126.
Instincts, of neuter insects, 127 ; injurious to the individual, 132.
Invertebrata of the Chalk, 149.
Ivel district, rainfall in, in 1883, 116 ; in 1884, 250.
Ivinghoe, whirlwind at, in 1834, 236.

J.

James, J. H. : Curious Habit of the Wagtail, lxii, 237-238.
Jeffreys, Dr. J. Gwyn : List of Land and Fresh-water Mollusca observed in Hertfordshire, xiv, 29-32 ; notice of, 158.
Jones, Prof. T. Rupert : The Origin and Composition of Chalk and Flint, with special reference to their Foraminifera and other Minute Organisms, lii, 143-156.

K.

Kataplexy, 128.
Kelshall, geology of country round, 35; boulders at, 41, 42; microscopic structure of doleritic boulder from, 49.
Kensworth, rainfall at, in 1883, 115; in 1884, 249.
Kent, W. S., on the collared monads, 97.
Kingfisher in Herts, 88.
Kingston, A., phenological observations by, in 1883, 191; in 1884, 228.
Knebworth, rainfall at, in 1883, 115; in 1884, 249; Lepidoptera of, 261, 265, 266.

L.

Lamellibranchiata of Herts, 29.
Land Mollusca, remarks on, 17; observed near Watford and St. Albans, 26.
Langley, Rev. J. C., plants observed in Herts by, 101.
Lea district, rainfall in, in 1883, 116; in 1884, 250.
Leavesden Woods, Watford, visited, xli.
Lepidoptera of Sandridge, 58; list of, 62; of Hitchin and Knebworth, 261.
Library, donations to, in 1883, xxxiv; in 1884, lviii.
Lichens of Bricket Wood, lxxii.
Light attracting animals, 133.
Lightning, ball, ix.
Limestones, boulders of, in North Herts, 45.
Limnæidæ of Herts, 30.
Lingen-Seager, Rev. J., on bee-keeping, xxxix.
Linley, G. F., on boulders at Newport, Essex, 43.
Linota flavirostris in Herts, 82; *linaria*, 208.
Little Hadham, *see* Hadham.
Littleboy, J. E.: Notes on Birds observed in Hertfordshire during the year 1883, xxxvii, 82-90; Notes on Birds observed in Hertfordshire during the year 1884, lx, 207-218; Whirlwind at Ivinghoe, 11th Sept., 1834, lxii, 236-237; remarks on the acclimatization of fishes, li; Grayling in the Colne and Gade, li.
Lloyd, F. G., remarks on the acclimatization of fishes, li.
London Tertiary Basin, xlii; explanatory of, lxvi.

M.

Macmillan, Rev. Hugh, on mosses, 68.
Maynes Farm, St. Albans, visited, xlviii.
Meteorological observations taken at Throcking in 1883, 103; in 1884, 239; at Watford in 1883, 181; in 1884, 219.
Meteorology and some connected subjects, ix; note on, 236.
Mice, singing, xxxviii.
Microscopic structure of North Herts boulders, 47.
Migrants, summer, in Herts, in 1883, 84; in 1884, 211.
Miner-fly, attack of, in Herts, 92.
Minute organisms of chalk and flint, 143.
Miscellaneous notes, 236.
Mollusca of Rickmansworth Common Moor, xl; of Aldbury Owers, xl; of the Chalk, 149.
Mollusca, land, remarks on, 17; observed near Watford and St. Albans, 26.
Mollusca, land and fresh-water, recorded in Herts, 10; observed in Herts, 29.
Molluscoida of the Chalk, 150.
Montague on the hen-harrier, 83.
Moor Park, Rickmansworth, rainfall at, in 1883, 115; in 1884, 249.
Mosses of Verulam Woods and Gorhambury Park, St. Albans, xlviii; of Aldbury and Ashridge Park, lxiii; of Bricket Wood, lxxii; notes on, 67; list of Herts, 71.
Moss-flora, Herts, 67, 72.
Much Hadham, *see* Hadham.

N.

Nascott House, Watford, visited, xli.
Nash Mills, rainfall at, in 1883, 115; in 1884, 249.
Natural selection and coinage of the Ancient Britons, xxiii.
Neocomian beds, 144.
Nesting places, curious, 89.
Nests and eggs of birds, 255.
Neuter insects, instincts of, 127.
Newberries, Radlett, visited, xlii.
Newnham, pit-section at, 41.
Newport (Essex), boulder at, 43.
New River Company, origin and history of, lxix.
Nightingale in Herts, 213.
North Herts boulders, 33; microscopic structure of, 47.
Notes, miscellaneous, 236.

O.

Observation, 157.
Observations, meteorological, at Throcking, in 1883, 103; in 1884, 239; at Watford, in 1883, 181; in 1884, 219; phenological, in Herts, in 1883, 191; in 1884, 227; miscellaneous, 236.
Odsey, rainfall at, in 1883, 115; in 1884, 249; phenological observations at, in 1883, 191; in 1884, 228.
Officers and Council for 1884, xvi; for 1885, liii.
Ordinary meetings, reports of, 1883, ix-xiv; 1884, xiv-xv, xxxvi-xxxix, xlix-li; 1885, lii, lx-lxii, lxv.
Organisms, minute, of chalk and flint, 143.
Ornithology, note on, 237.
Ostracoda of the Chalk, 152.
Owls in Herts, 214.

P.

Paludinidæ of Herts, 30.
Papers read in 1883, xvii; in 1884, liv.
Park Street visited, xxxviii.
Partridge in Herts, 215.
Patmore Heath, well-section near, 173.
Pectinibranchiata of Herts, 30.
Phalausteridæ of Herts, 97, 100.
Phenological observations in Herts in 1883, 191; in 1884, 227.
Phillips, F. W.: Notes on the Protozoa of Hertfordshire: section Discostomata, xxxvi, 95-100.
Phyllotreta undulata, attack of, in Herts, 93.
Plants, flowering, observed in Herts in 1883, 101.
Plover, ringed, in Herts, 215.
Pochard in Herts, 89.
Polycistina of the Chalk, 152.
Ponsbourne Park, well-section at, 177.
Porphyrites, microscopic structure of boulders of, 51.
President's Address, 17th Feb. 1885, 157.
Pressure (atmospheric) at Throcking in 1883, 104, 106; in 1884, 239, 240; at Watford, in 1883, 184; in 1884, 220.
Prestwich, Prof. J., quoted, xliii.
Pryor, M. R., on boulders at Newport, Essex, 43.
Puffin in Herts, 89.
Pulmonifera, 17; of Herts, 31.
Pulmonobranchiata of Herts, 30.

Q.

Querquedula circia in Herts, 210.

R.

Radlett visited, xli; Herts conglomerate at, xlii; swallow-holes near, xliv; Mollusca of, 29.
Rainfall in Herts in 1883, 112; in 1884, 247; at Throcking, in 1883, 105, 107; in 1884, 241, 242; at Watford, in 1883, 185; in 1884, 221.
Range of the Chalk, 143.
Ransom, F.: Diatoms: their Nature and Habits, lx, 197-206.
Raven in Herts, 214.
Reading beds at Radlett, xlii; near Hertford, lxvi.
Receipts and expenditure, 1875-84, xx; in 1883, xxi; in 1884, lvii.
Redbreast in Herts, 86.
Redpoll, lesser, in Herts, 87; mealy, in Herts, 208.
Redstart in Herts, 86.
Regulus ignicapillus in Herts, 207.
Report of the Council for 1883, xvi; for 1884, liii.
Report on the rainfall in Herts, in 1883, 112; in 1884, 247; on phenological phenomena in Herts, in 1883, 191; in 1884, 227.
Reptiles of the Chalk, 149.
Rhabdoliths of the Chalk, 154.
Rickmansworth visited, lxiv; rainfall at, in 1883, 115; in 1884, 249.
Rickmansworth Common Moor visited, xxxix; Mollusca of, xl.
Robinson, I.: The Diatomaceæ; with special reference to Species found in the neighbourhood of Hertford, xiv, 1-9.
Roebuck, W. D., and J. W. Taylor: The Recorded Occurrences of Land and Fresh-water Mollusca in Hertfordshire, xiv, 10-16.
Rooper, G., remarks on the acclimatization of fishes, l.
Rothamsted, rainfall at, in 1883, 115; in 1884, 249.
Royston, boulders at, 41; rainfall at, in 1883, 115; in 1884, 249; phenological observations at, in 1883, 191; in 1884, 228.
Royston Heath, dotterels seen on, 84.
Rush Green, Eocene section near, lxvii, lxviii.

S.

St. Albans, ordinary meeting at, 1884, xiv; field meeting at, 1884, xlvii; Mollusca of, 26; rainfall at, in 1883, 115; in 1884, 249.
Salpingœca tuba (Phillips), sp. nov., 100.
Salpingœcidæ of Herts, 97, 99.
Sandon, pit-section at, 40; microscopic structure of granitic and of gneissic boulder from, 53.
Sandridge, Mollusca of, 29; Lepidoptera of, 58, 62.
Sandstone, boulders of, in North Herts, 44.
Sawbridgeworth, well-sections at, 177, 178; phenological observations at, in 1883, 191; in 1884, 228.
Scale-mosses of Herts, xlviii, lxiv, lxxii.
Schists, microscopic structure of boulders of, 53.
Seebohm, H.: The Nests and Eggs of Birds, lii, 255-260; on the hen-harrier, 83; on the fire-crest, 207; on the waxwing and chough, 208; on the little bittern, black tern, and great northern diver, 209.
Selby, Ada: List of Land and Fresh-water Mollusca observed in Hertfordshire, xiv, 29-32; List of Flowering Plants observed in Hertfordshire during the year 1883, xxxvii, 101-102; during the year 1884 (title only), lxii.
Sense of direction, 136.
Sheldrake in Herts, 210.
Shoveller in Herts, 210.
Shrike, great grey, in Herts, 87, 213; red-backed, in Herts, 213.
Silvester, F. W.: Report on Insects observed in Hertfordshire during the year 1883, xxxvii, 91-94; during the year 1884, lxv, 233-235.
Southgate, rainfall at, in 1883, 115; in 1884, 249.
Skylark in Herts, 87.
Spatula clypeata in Herts, 210.
Spheriidæ of Herts, 29.
Sponges of the Chalk, 150.
Spurrell, F. C. J.: On Deneholes (title only), xv.
Starfishes of the Chalk, 150.
Stevenage, boulders near, 42; hen-harrier seen near, 83; rainfall at, in 1883, 115; in 1884, 249.
Stork, white, in Herts, 89.
Stortford, *see* Bishop's Stortford.
Structure, microscopic, of North Herts boulders, 47.
Sula bassana in Herts, 210.
Swallow-holes near Battler's Green, xliv.
Symons, G. J.: On Meteorology and some Connected Subjects, ix-xiii.

T.

Tadorna cornuta in Herts, 210.
Taxus baccata, poisonous effects of, xxxvii.
Taylor, J. W., and W. D. Roebuck: The Recorded Occurrences of Land and Fresh-water Mollusca in Hertfordshire, xiv, 10-16.
Temperature at Throcking in 1883, 104, 106; in 1884, 240, 242; at Watford in 1883, 184; in 1884, 220.
Tephritis onopordinis, attack of, in Herts, 92.
Tertiary, London, Basin, xlii; explanation of, lxvi.
Testacellidæ, 18, 21.
Thame district, rainfall in, in 1883, 116; in 1884, 250.
Therfield, height of water-parting at, 35; pit-sections at, 36; rainfall at, in 1883, 115; in 1884, 249.
Throcking, rainfall at, in 1883, 105, 107, 115; in 1884, 241, 242, 249; meteorological observations at, in 1883, 103; in 1884, 239.
Time, true, xii.
Tipula oleracea, attack of, in Herts, 93.
Totternhoe stone, 144, 146.
Tree-sparrow in Herts, 87, 214.
Tring, Mollusca of, 29; rainfall at, in 1883, 115; in 1884, 249.
Tunnel Woods, Watford, visited, xli.
Turnford, well-section at, 176.
Turnip-fly, attack of, in Herts, 93.
Twite in Herts, 82, 214.

U.

Unionidæ of Herts, 29.
Upupa Epops in Herts, 82.

V.

Valvatidæ of Herts, 30.
Vertebrata of the Chalk, 149.
Verulam Woods, St. Albans, visited, xlvii; fungi and mosses of, xlviii.
Visitants, spring, autumn, and winter, in Herts, in 1883, 86; in 1884, 213.

W.

Wagtail, curious habit of, 237.
Wagtails in Herts, 87.
Waltham Cross, well-section at, 179.
Walton, Izaak, at Amwell, lxix.
Wansford House, Watford, rainfall at, in 1883, 115, 185; in 1884, 221, 249; meteorological observations at, in 1883, 181; in 1884, 219; situation of, 181.
Ware visited, lxv; Mollusca of, 29; rainfall at, in 1883, 115; in 1884, 249; well-section at, 179; phenological observations at, in 1883, 191; in 1884, 228.
Ware Park, *Monosiga globosa* in, 98.
Watford, ordinary meetings at, 1883, ix-xiv; 1884, xiv-xv, xxxvii-xxxviii, xlix-li; 1885, lii, lx-lxii; anniversary meetings at, 1884, xv; 1885, liii; field meeting at, lxx; Mollusca of, 26, 29; rainfall at, in 1883, 115, 185; in 1884, 221, 249; well-section at, 180; phenological observations at, in 1883, 191; in 1884, 228.
Watford House, rainfall at, in 1883, 115; in 1884, 249.
Watford tunnel, flints from Chalk of, 156.
Waxwing in Herts, 208.
Well-sections in Herts, 173.
Welwyn, rainfall at, in 1883, 115; in 1884, 249.
Westmill, boulders at, 42.
Weston, boulders at, 42.
Wettest days in 1883, 117; in 1884, 251.
Whirlwind at Ivinghoe in 1834, 236.
Whirlwinds, xi.
Whitaker, W.: Some Hertfordshire Well-sections, lx, 173-180; section of Tertiary beds near Hertford, lxvii.
White, Gilbert, on the hoopoe, 83.
Widbury Hill chalk-pits, lxx.
Willis, J. J., insects observed by, 92, 93; phenological observations by, in 1883, 191; in 1884, 228.
Wimbrel in Herts, 88.
Wind, force of, xii; at Throcking, in 1883, 105; in 1884, 241; at Watford, in 1883, 185; in 1884, 221.
Woodcock in Herts, 88.
Woodpeckers in Herts, 87, 214.
Woolwich and Reading beds at Radlett, xlii; near Hertford, lxvi.

Y.

Yarrell on the hoopoe, 82.
Yew, poisonous effects of, xxxvii.

Z.

Zoological Gardens, Regent's Park, visited, xix.

ERRATA.

Page 77, line 14 from bottom, *after* "*pumila*" *insert* "Hedw."
,, 126, bottom line, *before* "spiders" *insert* "of the."
,, 260, line 14 from bottom, *before* "cormorant" *insert* "pigmy."

APPENDIX.

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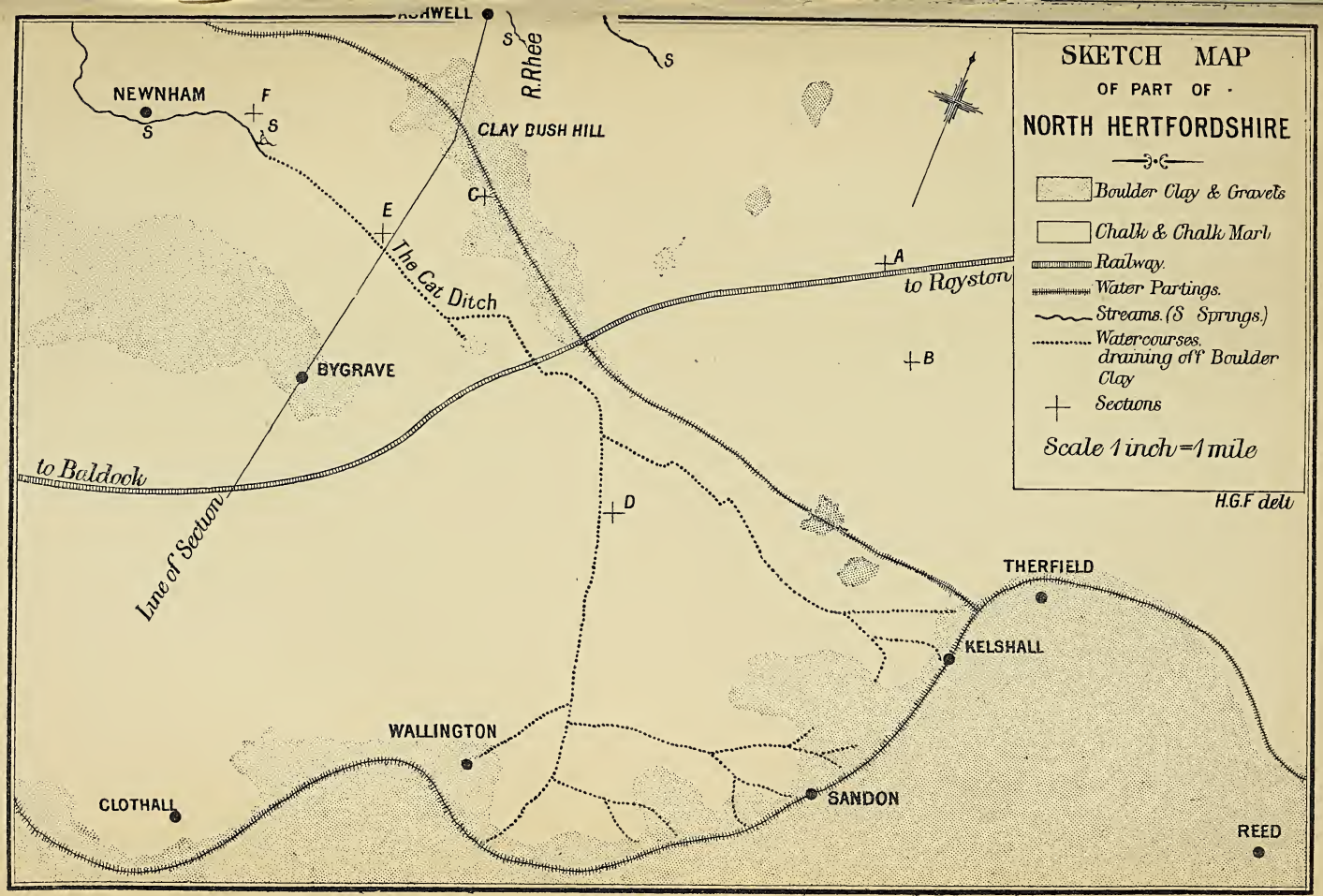
1881 Warner, Miss Alice, *Woodlands, Hoddesdon.*
1881 Warner, Henry, *Wormley, Hoddesdon.*
1875 Waterman, George, *Queen's Road, Watford.*
1881 Weall, John, *Rutland Lodge, St. Andrews, Watford.*
1880 White, Miss Anne, *North Crescent, Hertford.*
1879 White, Miss Rose, *Maisonnette, St. Albans.*
1880 White, S. Monckton, *Elmsleigh, St. Albans.*
1879 Whitley, Charles, *Hope Villa, Ware Road, Hoddesdon.*
1881 *Wigram, Miss E., *Moor Place, Hadham.*
1879 Wilds, William H., *Hertford.*
1875 Wilson, John, 159, *New Bond Street, London, W.*
1875 *Wilson, Miss Mary, *Nutfield, Watford.*
1880 Wingfield, Rev. Canon, M.A., *The Rectory, Welwyn.*
1882 Wood, Henry, *Woodside, Leavesden, Watford.*
1879 Woodhouse, John, M.D., *St. Andrew's Street, Hertford.*
1883 Woodley, Miss, *Ware Road, Hertford.*
1882 *Woods, Thomas Hoade, *Durrants, Watford.*

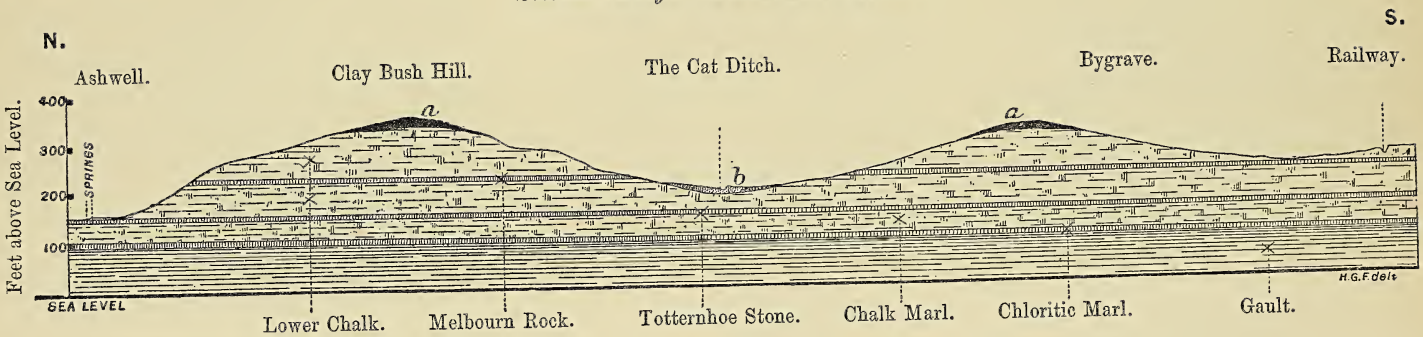
1883 Young, Mrs. Charles, *Fore Street, Hertford.*

END OF VOL. III.

STEPHEN AUSTIN AND SONS, PRINTERS, HERTFORD.


ASHWELL
R.Rhee
S
S
NEWNHAM
S
F
S
CLAY BUSH HILL
C
E
The Cat Ditch
A
to Royston
B
BYGRAVE
to Baldock
Line of Section
D
THERFIELD
KELSHALL
WALLINGTON
CLOTHALL
SANDON
REED
SKETCH MAP
OF PART OF
NORTH HERTFORDSHIRE
Boulder Clay & Gravels
Chalk & Chalk Marl
Railway.
Water Partings.
Streams. (S Springs.)
Watercourses draining off Boulder Clay
Sections
Scale 1 inch = 1 mile
H.G.F delt

Section through Ashwell and Bygrave.



a = Boulder Clay and Gravels.

b = Gravel and Chalk Rubble.

0 1 mile.

1. Dolerite.

2. Dolerite.

3. Dolerite.

4. Basalt.

5. Basalt.

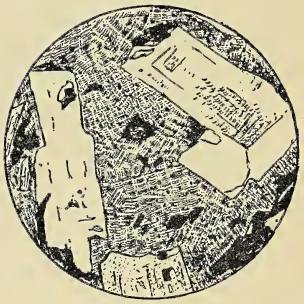
6. Basalt.

Sections of Hertfordshire Boulders.

1. Basalt.

2. Basalt.

3. Porphyrite.



4. Porphyrite.

5. Porphyrite.

6. Granite.

SECTIONS OF HERTFORDSHIRE BOULDERS.

1. Granite.

2. Granite.

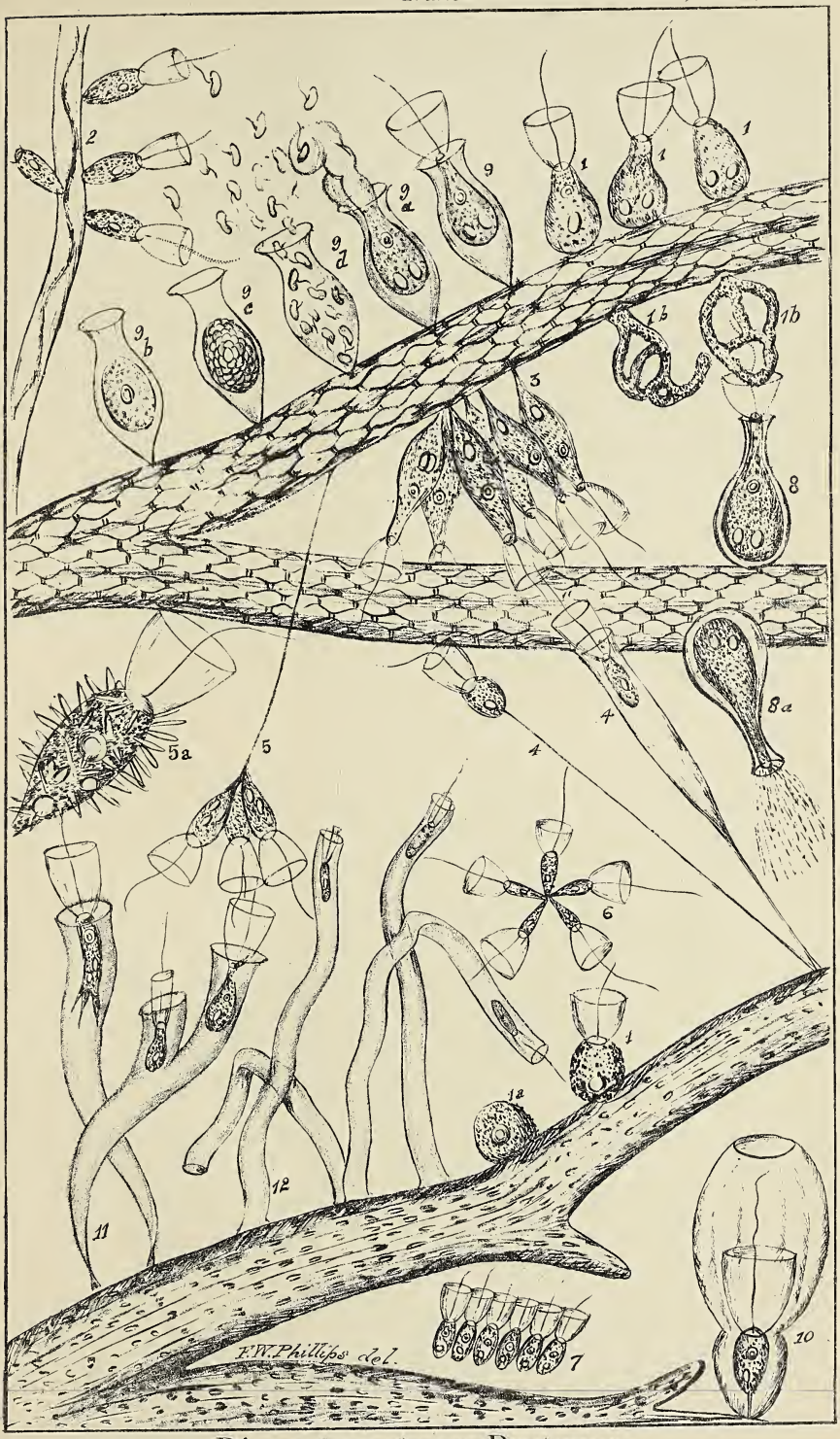
3. Granite.

4. Gneiss.

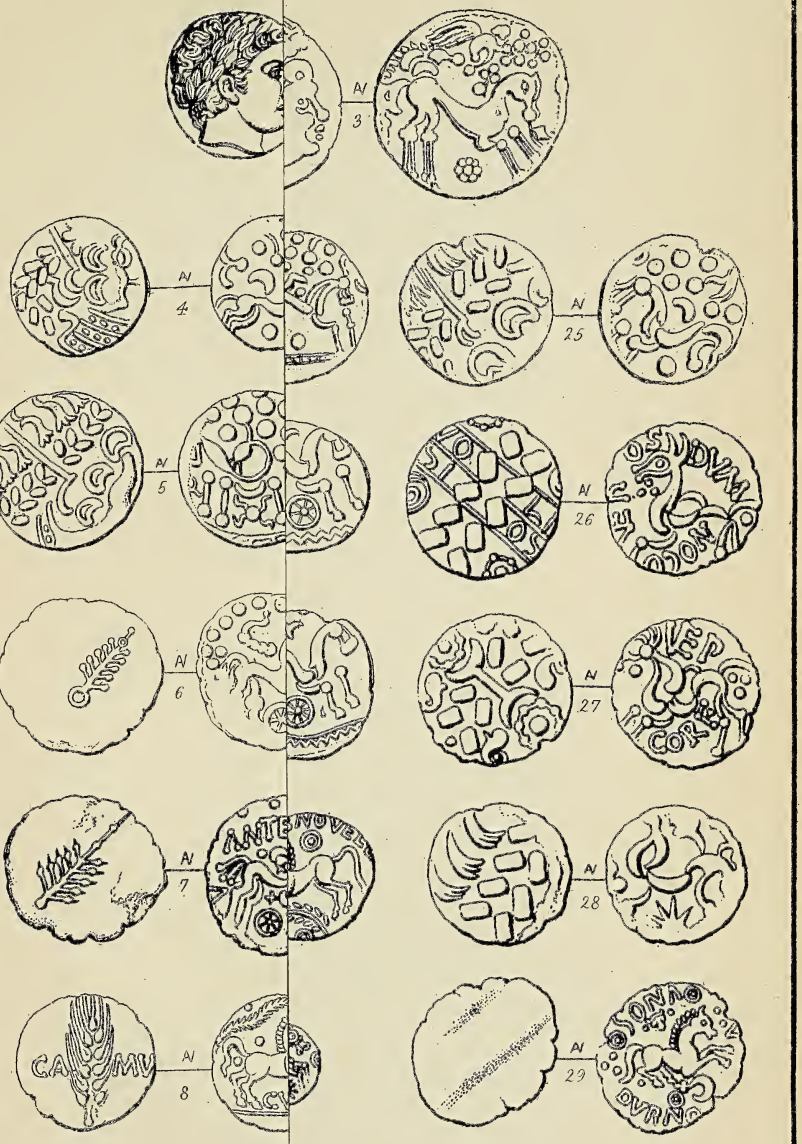
5. Gneiss.

6. Schist.

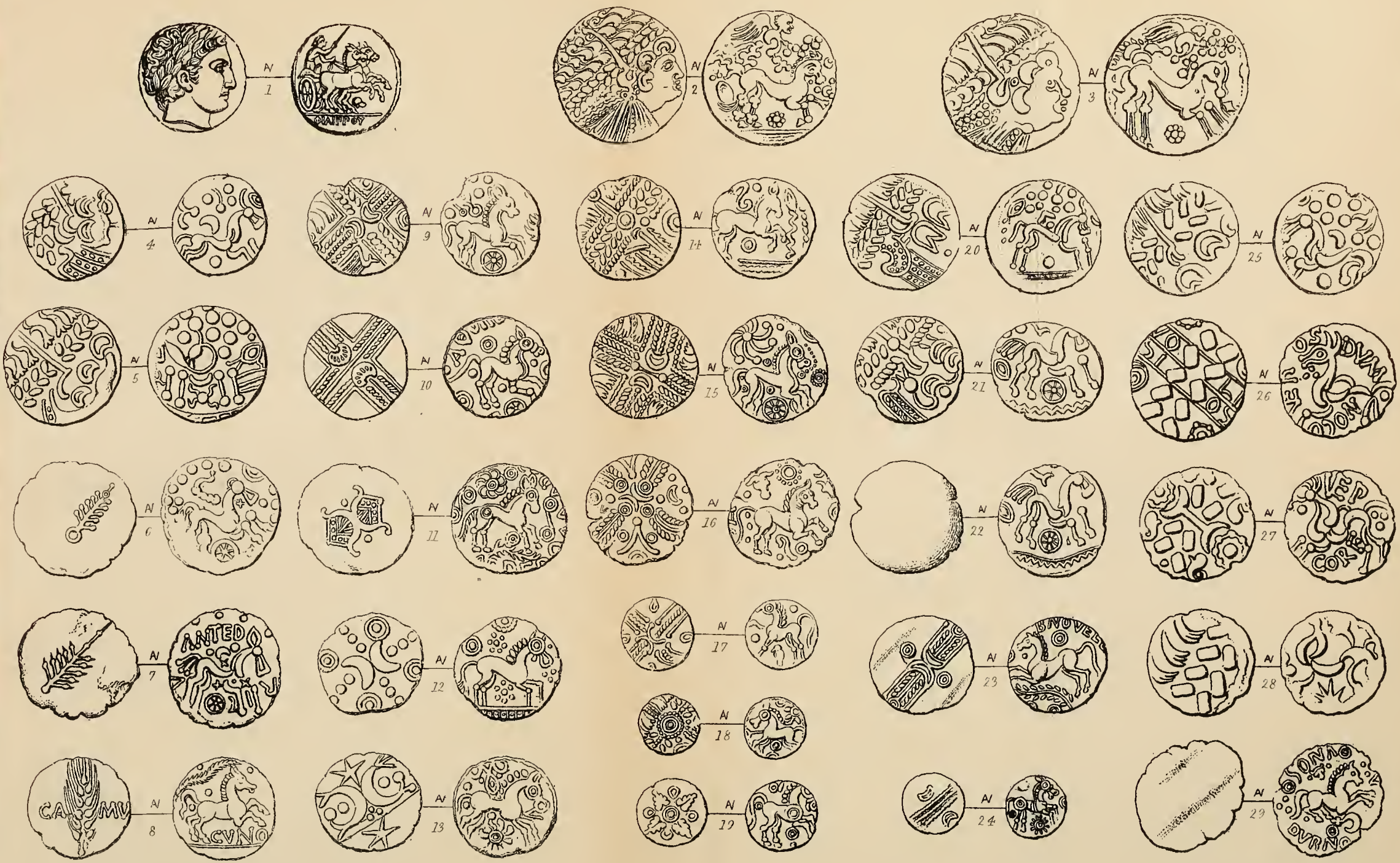
SECTIONS OF HERTFORDSHIRE BOULDERS.



Discostomatous Protozoa.



COINS.



EVOLUTION OF TYPES ON ANCIENT BRITISH COINS.

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